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INDUSTRIAL PSYCHOLOGY

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CONTENTS

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C. S. M.

LONDON,
July 1943

CHAPTER I

INTRODUCTION

By Charles S. Myers

With the exception of one chapter, which was most kindly supplied at relatively short notice by Dr. Drever, this book has been written by members or ex-members of the staff of the National Institute of Industrial Psychology. As its Director I was asked in 1928 to contribute an introduction to their work. But I could wish that my relations with the authors were not so close, as I could then commend the book without fear of being swayed by prejudice or partiality.

I can say honestly, however, that I know of no other similar volume in which the principles and methods of Industrial Psychology are sketched in such clear and readable language. It easily surpasses an early attempt (*Mind and Work*, 1921) which I made when the subject was still, so to speak, in its swaddling-clothes, to present a popular exposition of it. And it is far less technical and more attractive than my second effort (*Industrial Psychology in Great Britain*, 1925),

which, however, may prove useful to readers of this volume who desire further details in regard to certain chapters.

But this greater interest of the present volume is only natural. For it has been written not by one who has had to occupy himself largely with administrative work, but by a band of able young investigators who have spent several years in uninterrupted, immediate contact with employees and management in factories, mills, mines and offices. It is the fruit of their first-hand experience, supplemented by the more specialized research work of the Institute and particularly of the Industrial Fatigue (now Industrial Health) Research Board.

Although this book itself provides detailed answers to the two questions—what is Industrial Psychology ? and why has it met with such success in this country ?—I should like to attempt here a more general and briefer reply to them. Industrial Psychology is the most recent application of the youngest of the Natural Sciences. Psychology, the science of the mind, has emancipated itself completely from the leading-strings of Philosophy by which it was first nurtured. Like Physiology it has now become established as a branch of Biology, dealing with the functions of the living mind just as the former deals with the functions of the living body.

Like every other Natural Science, Psychology

as it developed gave birth to several Applied Sciences. From it arose Psycho-pathology and Educational Psychology, which are the very foundations of Psychological Medicine and Pedagogy. The most recent example of Applied Psychology is Industrial Psychology, which is concerned with the human factor throughout industry—" industry " being construed here in its widest sense so as to include all occupations, whether they be in the factory, in the office, or among the professions, and all workers, whether they be directors, managers, foremen or among the rank-and-file.

Industrial Psychology includes Industrial Physiology in so far as it is impossible to separate mental from bodily activities in their inter-relation and inter-action. Its aim is to discover the best possible human conditions in occupational work, whether they relate to the best choice of a vocation, the selection of the most suitable workers, the most effective means of avoiding fatigue and boredom, the study and provision of the most valuable incentives to work, the causes of and remedies for irritation, discontent and unrest, the best methods of work and training, the reduction of needless effort and strain due to bad movements and postures, inadequate illumination, ventilation and temperature, ill-considered arrangements of material, or defective routing, layout, or organization.

The Psychologist's Methods

Like any other science, Industrial Psychology seeks out causes before it recommends remedies. It deals with the worker as a living mental organism, not as a blind, lifeless machine. Its methods are fundamentally those of Biology, not those of Mechanism. Let me give an example so as to indicate what Industrial Psychology is *not*.

The output of a certain department in a large firm was considerably increased by halving the number of workers in it and by offering a substantial bonus on increased production to those who remained. The firm appeared proud of having achieved success by methods which they considered sounder and simpler than those of Industrial Psychology. But it must not be overlooked that it would have been the lazier and less efficient workers that were withdrawn and that the pace of the rest and the general "atmosphere" of the department would be thus improved. It is also clear not only that in this particular case the workers who remained would be spurred to greater exertion through fear of a similar fate of removal, but that in any factory nearly every worker could be forced to increase his speed of work under the incentive of threatened unemployment or of increased earnings. But the effects of such crude inducements must be far less permanent than those which are based

on a scientific enquiry by those trained in psychology and physiology into the manifold causes that had prevented the workers from giving their best.

Only when slow habits have been allowed to develop, and only when—which seldom happens—reduced output is solely due to such habits, are methods like these likely to have any enduring value. Neither fear nor a bonus provides a lasting stimulus, especially where other causes of deficient output remain unremedied. In by far the majority of cases, slackness is due to bad management and is therefore to be radically cured not by introducing even an appropriate incentive, but by removing the features of that bad management—by dismissing inefficient, uncongenial overseers, by abolishing waiting for material and other causes of unproductive time, by instructing workers in the best methods of work. Merely to induce in them anxiety or to offer them a bonus, is much the same method as an ignorant driver might employ in attempting to improve an animal's pace by hitting him with a whip or by holding a carrot before his nose.

Consider the problem further by analogies from medicine. If the human heart is acting badly, it would be absurd to administer a cardiac stimulant or sedative before the physician has ascertained whether the heart itself was at fault or whether the resistance which it had to overcome by its contractions was abnormally

increased. Again, when a man suffers from emaciation, it does not follow that the stomach is responsible and that the remedy necessarily lies in halving its food and in giving it a tonic: nutrition depends not merely on the stomach but also on the nervous system and on chemical processes in a vast variety of glands, tissues and organs.

We have accordingly to remember that a given effect may be the outcome of a large number of interacting causes in different parts of the entire organism. In treating the industrial, as in treating the human organism, we must therefore systematically reveal and carefully study the relative importance of these causes, before we can hope to apply rational treatment. It is seldom wise to rely merely on the administration of such remedies (and these solely to the worker) as fear and monetary gain.

The "Mechanical" Outlook

It is extraordinarily common to find the human factor ignored when mechanical improvements are introduced, or insufficiently considered when attempts are made to deal with it. For example, a firm which was evidently impressed with the greater output obtainable by better arrangements of material, set out to improve working conditions by altering the layout of the benches on which articles were assembled (i.e. put together). In so doing, however, they

entirely overlooked the fact that the levers of the presses on these benches were so awkwardly placed that each worker had to raise the right hand considerably above head-level in order to reach the lever, the whole operation being carried out with the right arm raised in a most awkward and fatiguing manner.

In another factory, girls were employed in filling with liquid small tins which they afterwards covered and labelled and returned to the inspection department. The management decided that the fetching and carrying of the tins were a waste of time. They introduced young girls for this work, and introduced still further specialization by allocating to separate groups of girls the work of filling, covering and labelling,—on the principle that, each girl having to carry out fewer, more easily-learned movements more frequently, output would increase. So it did, but only for a time. The deadly monotony of the work and the strain of attending to a few simple operations and of repressing other forms of activity ultimately reduced output to below its original level.

Many other similar cases might be cited; for instance, enforced seating of the workers under conditions when work could be done more comfortably standing or when alternate changes from a sitting to a standing posture would produce better results; or the suppression of apparently superfluous movements which in reality perform

a useful function in completing a series of rhythmical actions or in affording relaxation in a series of unusually strenuous ones.

The objection is sometimes urged—how can Industrial Psychology benefit the worker if, by its aid, as he produces more work per unit of time, still more work is heaped upon him by the management ? Even if he gain in earnings, how does he gain in ease of work ? The answer to this question is not difficult. The aim of Industrial Psychology is primarily not to obtain greater output but to give the worker greater ease at his work. Ease does not mean merely physical ease but also mental ease. If all causes of mental friction,—irritability, annoyance, anxiety and the like—are reduced, the worker will be all the happier, even if he has to work as hard as before. Industrial Psychology is always concerned in safeguarding the worker from over-fatigue. But in by far the greater number of cases, over-fatigue results not directly from over-action, but from worry, resentment, suspicion, etc. Remove these, increase interest, improve the general mental "atmosphere," and complaints of over-strain will mostly vanish. Routine must always enter into all activity—whether it be work or sport. What reason is there that our attitude to work and sport should differ so widely as it does at the present day, especially with the fuller development of the ideals of social service ? Why should we not

entertain the economic and social ideal that as output increases per worker he may be enabled to earn more not only in wages but also in leisure? Why again should not the ideal result of increasing machinery ultimately be not to increase monotony but to reduce it? For such repetitive work as feeding a machine must surely be ultimately done automatically instead of by human hands. And as machinery goes on increasing and provides a substitute for human drudgery, a growing demand will arise for the more interesting and intelligent work of *machine-minding*.

CHAPTER II

THE HUMAN FACTOR IN INDUSTRIAL RELATIONS

By J. Drever

THE discussion of the problems of industrial relations has passed through some curious phases in the last seventy years. In the first instance departure was taken from the current and orthodox political economy, which assumed a society of "standard economic individuals," differing in productive capacity and the like, but quite uniform as regards driving motives. This phase of the discussion might be called the *mechanical* phase, since, from this once orthodox point of view, an industrial undertaking might be regarded in its working as analogous to a complex machine, built up of more or less standard parts, all functioning in accordance with mechanical or quasi-mechanical laws. This phase was followed by a phase which we may call the *organic* phase. The standpoint in this case was more that of Herbert Spencer's social philosophy than that of the orthodox political economy. Spencer maintained that society ought to be regarded as a complex organism,

or at least as analogous to an organism. When this point of view is carried over to the case of a large industrial undertaking, we have an undoubted advance from the older point of view, since we are now taking into account the fact that the complexity of relations involved is analogous to that of vital functions, rather than of mechanical processes. This is obviously nearer the truth.

At the present time the discussion has entered on a third phase, which may be appropriately designated the *psychological* phase. It has come to be recognized that the complexity involved in industrial relations is not merely a complexity analogous to that of mechanical process in a complex mechanism, or to that of vital function in an organism. Neither of these analogies is adequate, or carries us far enough, though the second is a much closer analogy than the first. The related elements are human personalities. These present a complexity which may in certain aspects be both mechanical and organic, but is also—if we may use the word for lack of a better—spiritual. Industrial relations depend essentially on the interests, impulses, sentiments and passions of human beings. The realization of this fact is perhaps the brightest and most promising feature of the present industrial situation.

The study of the motive forces underlying the behaviour of the human being has made great progress in recent years. Hence it is possible to

give a far fuller and more adequate account of the human factor in industrial relations now, than it was, say, at the end of last century. When the older writers discussed the human factor at all, they concentrated attention mainly on the physical health and intellectual capacities of worker and manager. Important as these doubtless are, they play but a secondary part in the determination of industrial relations—that is, relations as between employer and worker, worker and foreman, worker and worker. Physical health and intellectual capacities are but tools in the service of deeper forces, and these deeper forces play a primary part in all relations between man and man, in the family, in social life, or in industry.

When we turn to the consideration of these deeper forces, we are in the first instance brought face to face with those "essential springs of all thought and action,"* which recent writers have identified as human instincts. Whether we call them instincts or not, is really indifferent. The essential thing is that they are powerful, and probably innate, motive forces underlying the thought and action of every human being. The mere enumeration of such motives as fear, anger, love, hate, pride, curiosity, and the like, can leave one in no doubt about this fact. Whatever the ultimate psychological analysis of these

* McDougall, W., *An Introduction to Social Psychology* (Methuen, 1926), p. 19.

phenomena of the mental life may be, it is at least certain that such are the motives which prompt and control the behaviour of human beings under all circumstances, in industrial life, or in the wider life of society at large. Industrial relations—and the same holds of family relations and social relations—become intelligible only when they are expressed in terms of these and such as these. The industrial world is constituted, not by economic individuals acting always under the influence and guidance of enlightened self-interest, but by human beings acting under the influence of human impulses, emotions, and passions, arising out of fundamental human needs.

While there is not one of the instinctive tendencies of the human being that may not on occasion play a prominent part in determining behaviour and affecting industrial relations, there are three or four which are of primary importance in this respect. These are the tendency towards the acquiring of property, underlying the sense of proprietorship or possession, the tendency towards self-assertion, expression, or display, the tendency to escape from a situation that threatens pain or loss, with its characteristic emotion of fear, together with the tendency to meet hindrance or obstruction with aggression, accompanied by the emotion we call "anger."

It must not be forgotten, however, that the

motives behind the behaviour of the human being are seldom simple. In any particular case many motives may be at work, some of them unknown to the individual himself. Moreover one motive may, under certain circumstances, give place to another entirely different. Thus anger and aggressiveness may readily displace fear or self-assertion, while fear may be involved in connection with a situation which primarily evoked self-display or acquisitiveness, and so on.

The Acquisitive Tendency

We may begin with the acquisitive tendency, since that most nearly conforms in character to the motive generally attributed to the individual in industrial relations by orthodox economic science. This tendency Ordway Tead speaks of in his *Instincts in Industry* as the "instinct of possession, ownership, property, or acquisitiveness," and he points out that it shows itself essentially in the "desire to identify property, whether in things, people, or ideas, with one's self," and moreover that it derives its satisfaction* less from "personal possession" than from "ultimate control." Here we have confirmation of what has just been said regarding the manner in which motives may be interwoven with one another. It is quite certain that this desire to identify anything with oneself, or to have control over anything, involves the self-

* P. 67.

assertive as well as the acquisitive tendency. This is especially evident where intangible rather than material things are in question. Be that as it may, there can be no question regarding the important rôle which this motive plays in many industrial situations. Tead has given several striking illustrations. On one occasion, he says, he "came across a young girl who was sitting at a sewing machine crying and sobbing violently. Enquiry revealed the cause of her sorrow to be that 'her own' machine had broken down, and that she was being required in the hour's interval to use another machine in perfect repair, and of identical make and capacity." In another case a strike in a foundry originated in the fact that a new foreman had transferred a man from one forge—"his own"—to another.

One may lay it down as a general principle that the organization of any industry must take account of this factor at all points at which it can possibly exert any influence. On the one hand it may function as a powerful stimulus to output. On the other hand it may be a fruitful source of trouble. In particular the relations between different grades may be strongly affected by any arbitrary action on the part of superiors which involves, or may involve, the ignoring of this element in a situation.

It is naturally in questions affecting wages that the acquisitive tendency shows itself most clearly. At the same time it is a great mistake to

suppose that its operation even here is unaffected and uncomplicated by the simultaneous operation of other natural tendencies, a mistake which the older school of economists were always in danger of falling into when they attempted to apply their findings directly to industrial life. Increase of wages means additional comforts, and even luxuries, for the individual himself, and those dependent on him, and to whom he is attached, as well as improvement in social status, with all that that implies. Moreover the desire itself for the things money will purchase does not always arise out of the thought of the direct satisfaction which the possession of these things will give, but frequently from seeing others in possession of these things.

Several writers have emphasized the extension of the instinct of possession to one's "job." At this point, as Tead has noted, one source of divergence and even antagonism between the views of employer and employee respectively is to be sought. The hostility of the striker towards the "black-leg" is partly due to the feeling on the part of the former that the latter is occupying his "job," to which he (the former) has a right. On the other hand the employer also claims the right to employ whom he pleases, since the "job" is his to give or to withhold. Of course there is another side to this that is no less worthy of being emphasized. If the worker feels that the "job" is his, then it tends to

become identified with himself like his other possessions, and his self-feeling extends so as to include it. In this fact we have one of the roots of craftsmanship. Here again the instinct of possession may be either a source of trouble or a stimulus to efficient work.

Self-assertion and the "Instinct of Workmanship"

Various writers have claimed that there is an instinct of "workmanship" or "craftsmanship." Thus Tead, in the work already quoted, writes: "There is in most people a fairly well-defined impulse to engage their energies upon some project that will grow under their hand—a delight in creation or at least in activity to which some use is imputed." * This impulse he identifies with the "instinct of workmanship." He also draws attention to the close relation between the "contriving impulse" and the sense of proprietorship. But there is no need to assume a special instinct of workmanship. The facts can be explained without any such assumption. The main instinctive root of the "contriving impulse" is the tendency towards self-expression, self-affirmation, or self-display—the "positive" self-tendency. What one produces or makes is under normal circumstances regarded as part of oneself. Where it is not so regarded counteracting influences are at work. Hence where the impulse of the craftsman appears to be inopera-

* Op. cit., p. 44.

tive, we must seek for the conditions which have produced a result that may be definitely regarded as unnatural and even morbid.

Some of these conditions reveal themselves at once as soon as we turn our attention to this problem. Mass methods of production naturally tend to prevent any identification of self with what is produced, since one's own work is not identifiable. But even under the conditions of factory production, if the right group spirit has been developed, the individual as a member of the group may have a feeling of proprietorship in the product of the work of the group. The absence of any feeling of ownership is bound to militate against the appearance of the craftsman's impulse. Then again a feeling of insecurity as far as the tenure of the "job" itself is concerned will inhibit the operation of that impulse, even when conditions are otherwise such that it might be developed. Above all, unsatisfactory conditions of work, low wages, irritating relations with foreman or employer, or anything in fact that produces discontent in the worker, will inevitably destroy any possibility of the workman taking a pride in his work. It may be impossible to secure this result under any circumstances, in which case other incentives must be sought, but no other incentives are so effective in producing the same kind of work.

We have suggested that the right group spirit

may have the effect of producing at least a very good imitation of the feeling of proprietorship in the product of the work of the group, and therefore something of the nature of the craftsman's impulse, even where the conditions are otherwise inimical. It will be necessary to return to this point later. It may, however, be observed here that human and personal relations between employer and employed, or between manager and employed, would seem to be an almost indispensable precondition for the development of this kind of group spirit. The more mechanical and less living the management of an industrial undertaking becomes, the more is such a possibility excluded. This indicates one disadvantage under which the industrial undertaking controlled by a large company, the individual directors of which may have no personal touch with the working of the concern, labours, as compared with one in which the heads of the firm are in constant and active relations with the work.

In discussing craftsmanship we have really passed from the consideration of the acquisitive tendency in its simple and direct operation to the analysis of motives in which it only plays a subordinate part, the important part being played by the tendency towards self-expression or self-assertion. This latter tendency is an all-pervading influence in industrial, as in social, life. Every man has an impulse in some degree to assert his individuality, and few things can

wound a man more deeply than to be treated as if he did not matter, as if he were a mere cipher. The manner in which orders are given, the attitude assumed by superiors to inferiors, the way in which men are taken on, paid their wages, or discharged, may be enormously significant for the efficiency of working of a factory, because of the influence of this factor. In this connection it is necessary to emphasize once again the advantage of the personally, as compared with the mechanically, controlled undertaking.

Tead, in discussing the instinct of what he calls "self-assertion," distinguishes between the two aspects "love of prominence" and "love of power." * From some points of view the distinction is useful, but we must not be misled into thinking of the two as fundamentally distinct motives. Both are expressions of one and the same instinctive impulse, "love of prominence" being probably the more primitive expression. Possibly the predominance of either in individual cases might be looked upon as the mark of a temperamental difference between individuals, and it is probably a difference to be carefully noted and studied with reference to vocational selection. However that may be, it is certain that both aspects are manifested on a wide scale in industrial life, as of course they are in social life at large. At the present time we

* Op. cit., p. 90.

can do little more than indicate the main directions taken by these manifestations.

The "love of prominence" has been frequently utilized by employers and managers to increase output by an appeal to rivalry and the spirit of competition. The effectiveness of the appeal is evidenced by the fact that unions have often felt called upon to intervene, and put a stop to the "speeding up" which has resulted. The reason usually assigned for such action on the part of the unions, viz. that the health and efficiency of the workers were bound to be affected, if not immediately, then certainly in the long run, is quite adequate and reasonable, so that there is no point in imputing less creditable motives.

One form of ambition also can be traced back to this "love of prominence." This form probably exerts its widest influence on industry in an indirect way, through the effect on the worker's efficiency of the desire to raise himself and his family in the social scale, or at least as an indirect result of social ambitions, which may be worthy or unworthy, reasonable or foolish, in varying degrees. *The system of promotion in* any industrial undertaking makes direct appeal to this motive. In order that it should exercise the maximum influence on the efficiency of the work done—not merely the output, but the efficiency on a long view—this system should impress the worker himself as fair in its operation and adequate in its recognition of efficiency. It

should therefore, where possible, be approved by the workers themselves, rather than imposed by the management. But the influence in industrial life which is more apt to arrest the attention of the close observer of industrial conditions is the influence on trades union policy of labour leaders acting under the sway of this kind of ambition, in most cases unconsciously as far as they themselves are concerned. To this point we shall have to return later.

The other form of ambition, which is more characteristically "love of power" than "love of prominence," usually affects industrial relations directly. In some men love of power is satisfied with power over material things, as over machinery, but in most cases the satisfaction is sought in power over other men. In proportion as this is secured the self-assertive impulses of these others must be thwarted. In extreme cases this very thwarting of the self-impulse of others is directly sought. There is no need to enlarge on the results that are bound to follow with respect to the relations between man and man. The domineering foreman, manager, or employer is always a potential source of serious trouble in industry. Then again the labour leader, who is always driven by this lust of power, will rarely rest satisfied with the control of his union, but will very frequently seek to make his power felt by employers, or it may be by other unions. This kind of ambition, which

not infrequently has its unconscious origin in frustrated ambition of a more worthy kind, is usually insatiable from its very nature—always seeking new worlds to conquer.

The Aggressive Impulse and the Instinct of Escape

Two further fundamentally important motive forces in industrial life, of the same order as those we have been discussing, remain to be mentioned. These are the aggressive impulse or the instinct of combat, and the escape impulse, with the emotion we call fear. A relatively strong aggressive impulse is usually characteristic of the form of ambition we have just been considering. The crude instinct of combat is directed towards the destruction of its object, but in the civilized human being mastery or domination displaces destruction. The mastery or domination must, however, be accompanied by the infliction of pain or humiliation on the object; otherwise it is merely the self-assertive impulse, without the aggressive, that is operative. On the other hand, the escape impulse is the response to disagreeableness, pain, or hurt, or to a situation that threatens these. It is, as it were, the obverse of the aggressive impulse. At the same time it must be noted—and this is very important—that the same kind of situation may evoke both, either together, or one after the other. In the former case a complex emotional

state is experienced, for which " hate " is probably the best designation; the latter case is illustrated in the animal world by the turning at bay of an animal in flight.

It is not difficult to understand how fear and aggression may be evoked by the same situation. The general situation which evokes the aggressive impulse is a situation which obstructs or thwarts some other impulse, desire, or purpose. If the desire thwarted is a fundamental one, such as one involving an essential need of the human being, aggression, with intense anger, is the natural response. On the other hand the disagreeableness is also intense, and the natural response to this is the impulse to escape with its emotional accompaniment of fear. At any moment one or the other may predominate, or both may fuse, as we have seen, to produce the complex emotional state of hate. Or, starting from a situation evoking the escape impulse in the first instance, we can arrive at the same final outcome. The natural response to pain or hurt of any kind is the escape impulse with the emotion of fear, the impulse and the emotion varying in strength and violence with the intensity of the pain. But pain, by the mere fact that it enforces attention, tends to inhibit any activity the individual may be engaged in, and therefore also evokes aggression with anger. We can thus see how the same situation will almost invariably evoke both aggression and flight, both anger and fear.

Conflict and Repression

The fact that flight and aggression may be simultaneously evoked introduces us to a phenomenon that has been strongly emphasized —perhaps over-emphasized—in recent psychological discussion. That is the phenomenon of conflict. Conflict arises when impulses which are incompatible with one another, or rather, which determine modes of behaviour that are incompatible with one another, are evoked simultaneously. The most frequent result of conflict is the formation of an emotional complex and repression. It is impossible to deal here with the psychology of the repressed complex. All that need be said is that an emotional complex is formed whenever mutually incompatible impulses are evoked by the same situation, and this situation is persistent or recurrent. When the emotional disturbance involved is a painful one, we try to escape from an intolerable situation by thrusting the whole thing as far as possible out of our minds, that is, by repression.

The phenomena of conflict and repression introduce us to *distorted* motives the potency of which in the causation of industrial unrest can hardly be exaggerated. Over the whole range of industrial relations distorted motives are by far the most frequent causes of difficulty and misunderstanding, and that because the behaviour in connection with which the difficulties arise can

never be taken, so to speak, at its face value. When the individual is not clearly aware of the real motives underlying his own behaviour, it is little wonder that he is misunderstood by others. Such a condition of affairs is the almost inevitable outcome of emotional complexes involving vital issues.

The worker is compelled by the necessity of earning a living to face daily the situations presented by the factory, or industrial undertaking of any kind, however repugnant they may be to him, and however much they may obstruct and thwart his real interests. If the conditions of work are so disagreeable to him, directly or indirectly, that he cannot help seeking an escape from them, and he is so enmeshed in the net of circumstance—a family to support, no other employment available, and the like—that escape is actually impossible, we have precisely the kind of situation in which repressed complexes naturally arise. What happens in such a case depends partly on the relative strength of the conflicting motives, and partly on the nature of the individual himself. One or other of the conflicting motives may have its way, but distorted in its operation by the presence of the other. If the escape impulse has its way the individual may escape by the flowery path of phantasy. His body is tied down to the uncongenial work, but his mind escapes into a realm where all his wishes are fulfilled, and all his

desires realized. Or he may be constantly on the look-out for an opportunity of changing his employment, becoming in consequence a very inefficient and unreliable workman, and possibly drifting about from one "job" to another. An excessive labour "turnover" may therefore be an indication that conditions are not satisfactory in any particular undertaking. This is an aspect of excessive labour turnover which must always be kept in mind. If, on the other hand, the aggressive impulse predominates, the aggression may be directed against relatively unimportant, or even more or less innocent, elements in the situation with a violence which is quite unintelligible unless we know all the facts. Frequently in this case the individual presents the well-known features of the "man with a grievance," who is always "agin the government," and who may cause a good deal of trouble, where circumstances favour the development of trouble.

The Individual and the Group

Up to now we have been preoccupied with motives in the individual, and with the relations between the individual and other individuals. When an individual is a member of a social group his impulses, feelings, and behaviour may be modified in various ways and degrees, dependent on the nature of the group in question. In any highly organized society the individual as a rule

belongs to a multiplicity of such groups. One of these is the trade union to which he belongs; another is the body of workers with whom he works. Both these social groups as such are important factors in the determination of industrial relations. In order to appreciate their precise significance we must first of all understand some of the phenomena characteristic of social groups.

A social group is not a mere aggregate of individuals. By becoming a member of a group the individual to some extent loses his individuality. He becomes part of a larger whole, which possesses a certain degree of unity, and in consequence he thinks, feels, and acts in a way different from that in which he would think, feel, and act in isolation. In particular the individual as a unit in a social group has what Le Bon, in his book *The Crowd, A Study of the Popular Mind*, has called a "sense or feeling of power" which diminishes the control exercised by the fear of the disapproval of others, and allows feelings and impulses, normally inhibited by this fear, to find expression. Moreover the sense of personal responsibility is also partly effaced, and the result is in the same direction, that is, towards the removal of inhibitions. Finally the opinions and beliefs of all the individual members of the group tend to become similar, apart from any rational grounds for such beliefs, and by the mere force of mass suggestion. The industrial application

of all this is so obvious that we need not delay to discuss it in detail. Of course there are variations in the degree in which these group characteristics are present in different groups, but it is a familiar fact that the industrial policy of a trade union tends to be carried out by the individual members, not as themselves rational and responsible beings, but as units in the social group.

An important characteristic of certain social groups is what is usually known as *esprit de corps* —which McDougall translates as "group spirit,"* and which he defines as "the idea of the group with the sentiment of devotion to the group developed in the minds of all its members." In order to understand the significance of *esprit de corps* we must understand the different types of social group that can come into existence. The most useful classification is on the basis of the mental level characteristic of the group as a group. Classifying on this basis, we may speak of the "crowd" type, the "club" type, and the "community" type. The "crowd" type of social group can have no *esprit de corps*. In its extreme form it comes into being when a number of individuals are brought by some circumstance or event to think, feel, and act together. As such it has no permanent memories, no stable aims, and therefore no group sentiment. The "club"

* *The Group Mind* (Cambridge University Press, 1927), p. 68.

type is characterized by the fact that the members have some common aim or sentiment, which is more or less stable and enduring, and in this case, therefore, *esprit de corps* can come into existence. The " community " type differs from the " club " type, on the one hand in the relative complexity of the aims and purposes that bind it together, on the other hand in the wider range and scope of its activities. With the " crowd " type behaviour is normally guided by impulse and emotion, of the kind we have discussed, with the " club " type by group sentiment and desire, and with the " community " type by rational purposes and ideals. Of course it must be understood that there are all degrees of transition from one to the other of these types.

It is obvious that in an industrial undertaking of any magnitude and permanence a type of social group approximating to the " community " type, ought, under ideal conditions, to be realizable. In actual fact the " crowd " type is only too frequently found. In some few cases we do find the " community " type. The conditions for the realization of this type are worth enquiring into. The first of these conditions is some continuity of existence of the group, both formal and material. Material continuity is the more important. That is to say, the labour turnover must be relatively small, the great body of the members of the group remain-

ing unchanged from month to month and from year to year. Secondly there must be definite group self-consciousness: the individual workers must be conscious of themselves as members of the group, and have a pride in the group as such. In the third place, there must be the right type of group organization. General principles only can be indicated here, the details being worked out for each special case. The organization of a group may be determined by custom and tradition, or it may be imposed on the group from without, or from above, or it may be consciously developed by the group itself. In industrial life all three methods of organization are exemplified, but the third is by far the most important for securing the best and most stable conditions. So far as the individual workers have a say in the organization of the work and the guidance of the policy of the undertaking, they feel a responsibility for its prosperity and its reputation, which they do not otherwise feel. The result is the reinforcing of the group loyalty arising from the *esprit de corps*, already assumed to exist, by all the fundamental motives determining industrial relations, which we have been considering, and particularly by the self-assertive impulse of each worker, since there is identification of the undertaking with the Self. Schemes of profit-sharing and the like, which give the worker a stake in the undertaking, are less likely to be effective in promoting the highest efficiency, than

the development on this basis of a spirit closely resembling what we know as the " team " spirit in sport, but in a more permanent and more serious form.

CHAPTER III

WORK AND ENVIRONMENT

By A. Hudson Davies

No science dealing with life can be complete, until it takes cognizance, not only of the inner mechanisms and adjustments by which life proceeds, but also of the relations between the living thing and its environment. The problems of the biologist and the psychologist are in this way unlike those of the physicist and the chemist, and are soluble with less precision. The final laws of a living science must be in terms of averages and express tendencies which, in any particular case, may be modified or suppressed by the situation of the moment. Work and environment are connected in this way, and the day has not yet come when principles are of such universal application, and quantitative and qualitative relations are so definite, that anyone with a text-book can make a Utopia of his factory.

In the past, environmental conditions—illumination, ventilation, humidity, temperature—have all been seen too much from the angle of

the engineer, but we are slowly realizing that the technical problem of obtaining any desired conditions is simple beside the psycho-physiological problem of what conditions suit the worker best.

Man is probably the most adaptable of living creatures. Where physical structure fails, he has intelligence to supplement its failure, and no other creature is able to maintain life, as a man can, at the equator and the pole, a mile underground and five miles in the air, in the Sahara and in a humid spinning-shed. Yet everyone knows that working efficiency—let alone comfort—varies greatly under such different conditions.

Pure research tries to discover the influence which such changes in environment exert on human life—health, comfort, efficiency. Industrial Psychology, armed with this knowledge, comes into the factory to find the best conditions for specific kinds of work. It is an ideal that the engineer should follow the psychologist to translate conclusions into practice, for one technician is the complement of the other. Actually, much of the work done by psychologists nowadays is done too late, for conservatism and the fixity of spent capital often make change difficult. Co-operation between engineer and psychologist begins properly at the drawing-board, since good conditions are easy to secure before ideas have clothed themselves in bricks

and mortar. It is a hopeful sign that the modern tendency is to seek the psychologist's advice before laying out the factory, instead of after.

Mental Environment

When we talk of the environment of work, we must resist the temptation to think only in terms of physical influences such as light, temperature, noise, for these are not the whole background against which work is set. The mind of every man carries desires, fears, anxieties, ambitions, hopes, friendships, ~~enmities—which~~ react upon his happiness and his efficiency. His personal feelings reflect also the more general feelings which pervade the group in which he is working : there are mass fears, mass anxieties, and mass loyalties, which we talk of loosely as " atmosphere " or " morale," and to which most of us pay lip service (although not always the tribute of intelligent understanding), as important factors in productive efficiency. Yet the intricate co-ordination of modern industry depends essentially on good mental environment, for production is hampered if co-operation between producers breaks down. There are workshops where men trust each other, and there are workshops where they do not. In the former, those difficulties between neighbouring processes and between departments, which arise in every factory, are smoothed away by

frank discussion and help. Where the factory atmosphere is bad, whether the responsibility for disunion rests on management, on foremen, or on men, any hitch in production is the seed of a quarrel somewhere, and the tale of spoiled work, low output, and wasted time mounts steadily. Capital loses profits, labour loses wages—nobody gains.

Towards the relief of such conditions the industrial psychologist must act as a physician to the body. He must discover the anxiety which turns the foreman into a bully, the self-assertion that prevents the shop manager from revising anomalous rates, the fear that causes workers to restrict output on this or that machine. If there are real grievances, he can separate them from the hundred and one unaccountable "grouses" which, in times of emotional stress, seem to focus themselves round the vital issue and sometimes to obscure it. Emotion drives clouds over reason; and often the outsider, only because he is outside, preserves a point of balance which can be of service to the malcontents. Disaffection has many causes but only one result—unhappy workers and poor work.

The roots of bad factory morale are not always economic, although wages and security are obviously dominant motives to any worker with the responsibility of dependants. Other things being equal, the low-paid factory on short time

can never have the same hold on the good will and eagerness of its workpeople that conditions of good pay and permanence obtain. But even physical factors have an important influence in shaping the mental background of work. A badly lighted workshop not only hampers production because the light is insufficient, but also because in a short time the workers are forced to spend more and more effort in maintaining the standard of work, and finally grow slack and cease to care. Conscientiousness gets no chance against permanently bad conditions. The responsibility for good conditions falls on management, and management has no more sensitive or stronger critics than its employees. A bad environment is resented by the worker for its discomfort if he has the imagination to conceive of a better one: but a feckless management he despises as well. A policy of *laisser-aller* on one side is quickly met upon the other. Good conditions are not only passively accepted: pride is often taken in obviously efficient and suitable surroundings for work, which is at once reflected in quality and quantity of output.

Although, therefore, as will be shown, attention to the physical environment of work is economically worth while, it must not be forgotten that the repercussions of good conditions do not stop at obvious efficiency only. Through the worker's mind they reach down to springs

of willingness and co-operation which are vital to the success of industry.

We must, however, turn now to consider more systematically the physical environment of work, dealing in succeeding sections with ventilation, temperature, illumination and noise, and their effects on the worker and his work.

Temperature, Air Movement, Humidity

It is only in comparatively recent years that the influence of ventilation on the comfort and efficiency of the body has been studied scientifically. Rule of thumb was inevitable in the absence of good scientific foundation work on the reactions of the body to changes in temperature, humidity and air movement. Except for the ordinary thermometer and the wet- and dry-bulb thermometer, there were not even instruments to measure accurately changes in the external conditions themselves, until the invention of the kata-thermometer by Dr. Leonard Hill put these problems into the field of quantitative research. To-day we are able to compare conditions, and to vary them positively and surely, with an accuracy which was undreamt of twenty years ago; and the further work of Dr. Hill and other investigators has made the general theory of ventilation clear.

Lassitude, discomfort, and fatigue are the experience of everyone who works in a "badly ventilated room," but before these researches

there were divisions of opinion on the reasons. One theory held that as breathing consumed the oxygen of the room and replaced it by carbon dioxide, the body became starved of oxygen. Another said that the symptoms were due to actual poisoning by the accumulating carbon dioxide. A third held that the body was slowly poisoned by certain exhalations given off by the body itself, in quantities too minute to be measurable but with a definite toxic effect on life.

Everyone, however, agreed on the practical steps to be taken. Vitiated air must be removed; fresh air must be injected in plenty. But practical remedies are often right for the wrong reasons. Research has now shown that none of these causes operates in ordinary circumstances, and that the important cause of fatigue and inefficiency is air stagnation. Fresh air is only one of possible remedies; there are workshops, e.g. spinning-mills, where too much fresh air is impracticable for technical reasons. The universal remedy is discovered to be *air movement*. Behind this fact lies the research which proved that the function of ventilation is to remove surplus heat from the body, and that the harm of stagnant air lies not in any chemical change, but in its lowered cooling power.

In complete rest and much more so in exercise, the surface of the body is continually radiating

the excess of heat produced in the physico-chemical changes which are the mechanical basis of life. If this heat is not removed the temperature of the body rises above normal. Automatically the surface blood-vessels dilate, in order to expose the blood more rapidly to the cooling action of the air, with the result that blood is diverted from the important visceral organs. Efforts to discharge waste heat are also made by sweating; and discomfort is still more aggravated if there be not ready absorption of this exuded moisture by the air.

The constant breathing of warm, moist still air has even more sinister effects; for the delicate mucous lining of the lungs becomes congested, loses tone, and forms a fertile breeding ground for bacteria. In cities like Chicago the pneumonia mortality is very severe, and most Americans and Scandinavians find English houses both draughty and chilly after their own central-heated homes, which have a warm, even temperature throughout. But the relatively low death-rates in England seem to justify our much-maligned system of coal fires and cold passages, for variation of cooling power from place to place in the house braces the system and heightens resistance to infection.

In the factory, however, the adjustment of cooling power to the nature of the work done is the main problem. The cooling power of the air declines with rising temperature, with

rising humidity, and with falling velocity of circulation. For every type of work there is probably an optimum combination of temperature, humidity, air movement, although the limits are vague and elastic. We shall presently discuss the essentials of the problem. But a note on the instruments used in such investigations must come first.

The thermometer used for measuring temperature is familiar to all. A variation of this is the wet- and dry-bulb thermometer in which two identical thermometers are exposed side by side, one normally, and the other with its bulb surrounded by a woollen wick which is kept wet by means of a small reservoir of water. According to the amount of moisture in the air, evaporation goes on more or less rapidly from this wick. The rate of evaporation in turn determines the temperature of the wick, which is lower the faster evaporation proceeds, and the drier the external air. If the air be completely saturated with moisture, both thermometers give the same reading; but at all other times the difference between them is a measure of the relative humidity of the air.

The third instrument is the kata-thermometer, which measures the cooling power of the air. It consists of a large bulb filled with liquid and joined to a capillary stem on which are two marks, corresponding to temperatures a little above and a little below the normal body

temperature of 98·4° F. In use the thermometer is suspended well away from any radiating body (it must not be held in the hand, for example). It is first warmed until the liquid rises above the top index, and then the time taken for the whole instrument to cool through the marked range is measured by a stop-watch. The observed rate of cooling is proportional to the cooling power of the air ; and by a suitable calculation, depending on the constants of each individual instrument, the theoretical cooling rate of the human body under the observed conditions can be inferred. If the temperature of the air is measured at the same time, it is possible to calculate the average velocity of air movement in the room. Readings must be taken many times in the same place, and in many places in each room, for the instrument is very sensitive to local conditions, and a chance puff of air may cause a large variation in the reading. It is also important to take readings at foot-level and at head-level, since a reversed cooling gradient —the head being warm and the feet cold—tends to great discomfort. General conclusions can only be based on very detailed and careful observation.

Ventilation and Efficiency

There is abundant evidence of the connection between efficiency and ventilation. Many criteria—output, sickness or accident rates,

labour turnover, etc., may be used, but space denies more than a few examples.

A survey of six years' working in five tinplate works, where the radiation from hot metal makes good ventilation difficult, showed that there was a close inverse connection between output and temperature, as shown by the following diagram.[1]

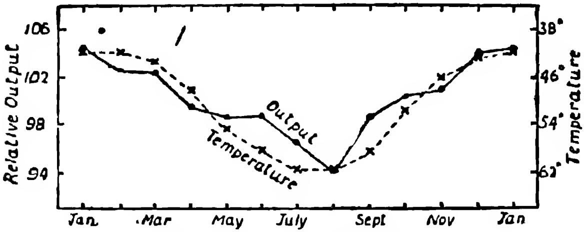

FIG. I.—(H. M. Vernon)

The output was 10 per cent. less in August than in January, when the average temperatures during these months were 62° F. and 42° F. In rolling-mills the output fell from 9 to 13 per cent. during the summer months, but the drop was less in works where the supplementary ventilation of the plant was very efficient.

Accident frequency was measured for a long period in three munition factories, where the temperature was registered continuously and automatically.[2] It was found that as the temperature rose from 52° F. to 67° F. the tendency to accidents grew less. At the lower

temperature there were 35 per cent. more accidents. As the temperature rose above 67°, the relative frequency of accidents rose sharply again also.

But of course there are many occupations where such a temperature would be excessive, and it is important not to fall into the trap of trying to standardize conditions proved to be good for one kind of work, for another kind with totally different requirements. Environment must always be adjusted positively to the necessities of the worker's mind and body; and these vary from job to job.

Where heavy manual work is done in hot surroundings as in gas plant, iron and steel works, glass blowing, etc., rapid air movement must be provided to offset the inevitably high temperatures. Other occupations, more sedentary in nature, which involve fine work and close bodily and mental discriminations—such work as assembly, small machining, weaving and shoe manufacture—are best performed with a moderate temperature and a lower rate of cooling. Unsuitable clothing on heavy work is common and there is much still to be done in educating the worker in the most comfortable forms of dress for work.

The influence of humidity is probably similar, but the study of its effect on output is complicated by the fact that excessive humidity in workshops is nearly always deliberately

introduced for technical reasons connected with the physical properties of the material being worked. In spinning, for example, a balance must be struck between too little moisture in the air, which makes the fibre intractable, and too much moisture, which lowers the efficiency of the worker.

In the words of a report of the Industrial Fatigue Research Board, "the air in a well-ventilated room should be (*a*) cool rather than hot, (*b*) dry rather than damp, (*c*) diverse in its temperature in different parts, rather than uniform and monotonous, and (*d*) moving rather than still." * This is a good summary of the position, but particular conditions must be worked out for particular cases.

Illumination

The conditions we have already discussed have an indirect relevance to work through their effect on the mental and physical efficiency of the worker. Bad lighting has a more immediate influence—it lowers output directly, increases spoiled work, and leads to overstrain. It is surprising that bad lighting is the most frequent fault in factories although sight is the most important sense in industry.

Two questions need to be asked about lighting

* "Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories." Industr. Fat. Res. Bd. Report, No. 11.

arrangements. First, is the amount of light needed for the work reaching the point of attack? Second (a question which contains many others), are the workers comfortable? Comfortable illumination is not always adequate (as we shall see later), and an increase of illumination which does not discommode the worker may often add to his production. But nothing is more certain than that uncomfortable conditions will lower output wherever the worker has the slightest influence on production.

Tables of minimum illuminations for many processes are found in books on lighting, but these are nearly all arbitrary in origin; and the scientific work of co-ordinating industrial process with optimum illumination has still for the most part to be done. We cannot make comparisons without standards, and it is necessary to warn the reader that the human sense organs, particularly the eyes, are almost useless for comparing the magnitude of one stimulus with another. The pupil of the eye automatically opens or closes to control the amount of light passing to the retina, while the retina in turn adapts itself, establishing a kind of equilibrium with the light stimulus and responding rather to changes in the stimulus than to its absolute magnitude. Since, in addition, no simple relation exists between the magnitudes of stimulus and sensation, judgments which do not depend on simultaneous comparison with a surface of

standard illumination (as in some older forms of photometer) are quite valueless. Illumination layouts in factories must therefore be controlled and verified by instruments.

When ordinary daylight is measured, it is found to vary greatly in intensity from time to time, although, in general, only sudden and relatively large changes are perceived by the eye. On a flat surface open to the noonday sun, illuminations as high as 10,000 foot-candles * have been registered, but variations of 200 per cent. may be quite imperceptible if they are reasonably slow. Interior illuminations are lower, a fall of upwards of 95 per cent. occurring as a window-sill is crossed. A maximum of 100 foot-candles may be reached near a window in a well-lighted room, but illumination falls off rapidly as one recedes from the windows. Rooms with top lighting have higher average illuminations on the whole, but variability is still uncontrollable. Measurements taken on a long desk in a composing room showed a variation from 43 f.c. to 266 f.c. and from 21 f.c. to 495 f.c. on two successive days. The ranges are typical.[3]

The relatively low intensity of interior daylight is due to the small area of sky from which

* Illumination is always referred to the foot-candle—the illumination produced on a certain standard surface by the light of a wax candle of definite size at one foot's distance.

rooms usually receive light, but dirty windows, after the lapse of six months without cleaning, have been shown to absorb 50 per cent. or more of the incident light, while dusty or dull-coloured walls absorb 40–90 per cent. of the light which would otherwise be reflected back on to the work.

Variations in daylight do not affect the worker greatly so long as the minimum illumination is high. But sometimes in the evening or during a cloudy day, the outside light may sink so imperceptibly that the light inside the building is reduced below the point where acuity is unaffected. Thus in one factory an investigator recorded readings as low as 0·2 f.c. at the vital point of a process towards 3.30 p.m. on winter afternoons, when no one had bothered to turn on the electric light. The workers said they were "used to the light," but spoiled work and eyestrain were definitely traced to this cause.

Bad *natural* lighting is a difficult problem because it is usually due to bad proportions in a room or to bad planning of adjacent buildings which are often incurable. We can only make the best of what nature and the architect have given us.

Artificial Lighting

Artificial lighting, however, is entirely in the hands of management; and there is no excuse at all for failing to make the best use of illu-

minants whose disposition and intensity are absolutely under control.

When daylight goes, there is a large drop in the average illumination. A representative figure for daylight illumination in a workroom might be 50 f.c., but an overall illumination of 10 f.c. after dark would be exceptional. A more likely average would be 3 f.c. (illuminations of this order of magnitude are common in spinning-mills). Such reduction in illumination is accompanied by a fall in production. The following curves obtained in a silk-weaving

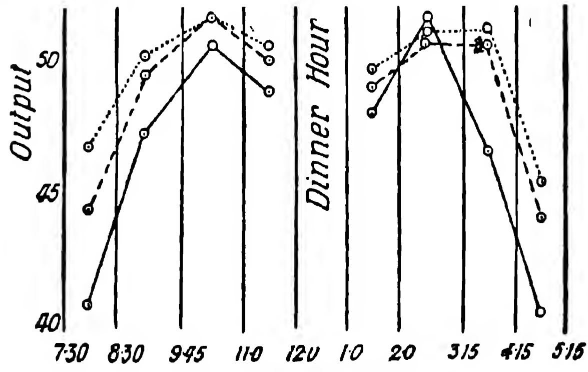

FIG. II.—(P. M. Elton).

shed show the distribution of output over different hours of the day for three consecutive periods of three weeks. The full line represents January 5 to January 24, the broken line January 26 to February 14, and the dotted line

February 16 to March 6. It will be seen that, as the days grow lighter, the curves get less irregular, output during the first and last periods of the day approximating more and more closely to the normal.

Investigations on composing showed that while the illumination for compositors' work in industry was in general about 7 f.c., an increase to 20 f.c. led to a reduction of errors, and to the elimination of the average 10 per cent. loss on daylight rates of output which was caused by the lower illumination of the work at night.[3] We shall probably grow accustomed to much higher illuminations than this, however, as the economic efficiency of lamps increases, for there are no theoretical reasons against the use of illuminations of 1,000 f.c., if only distribution is properly controlled. At present, however, cost and prejudice due to the unskilled use of high-intensity sources stand in the way.

General illumination of the required intensity is not always enough. It often happens that local circumstances in some way affect the illumination at the working point itself. In one factory, for example, small articles bolted to carrying-frames in dozens were clamped in a holder and dipped in lacquer tanks by the depression of a handle. There was a certain level distinguishable on the vertical sides of the articles, beyond which the lacquer must not

be allowed to go. If overdipped, the whole dozen lost a third of their value and might be completely spoiled. A single central light, placed about four feet above the tank, illuminated each dipping-tank, the illumination at the lacquer surface being 10 f.c. But unfortunately, owing to shadows cast by parts of the machine, and to the fact that the surfaces of the articles on which the safety level was marked were vertical and not horizontal, the illumination at the vital point was only 0·5 f.c. In fact, therefore, accurate working had no relation to the high general illumination, but depended on the successful judgment of relative levels on a surface with an illumination only of 0·5 f.c.

By a system of cross lighting with three low-power lamps instead of one of high power, side lighting was brought to bear on every vital surface, and the levels were then easily observable since the illumination of the least-favoured point was 3 f.c.—six times its former amount. The workers welcomed the arrangement, for much less strain was involved in working accurately. A considerable reduction in spoiled work followed.

Other problems of light distribution are not so amenable to the method of measurement. Of these "glare" is the most important. Although indirect lighting, sources of low brightness and careful shading are becoming more general than they were a few years ago, there are still

many places where no effort is made to get rid of the dazzle and irritation of unshaded ~~metal~~-filament lamps which annoy the eyes.

The discomfort of glare arises partly from the difficulties of the regulating mechanism we have previously described in adjusting the pupillary aperture when sharp intensity contrasts are present in the visual field, and partly from the tendency of the eye to bring any intense stimulus to the most sensitive central part of the retina. Glaring light points focussed on the edge of the retina compete for attention, ~~and the un~~-conscious efforts of the worker to keep his attention on his work and to discriminate its detail are likely to lead to strain and to be paid for in fatigue, headaches and spoiled work.

This is the least excusable of the defects of lighting systems. Glare is easy to remedy and the remedy nearly always involves the more economical use of the light.

Before concluding this section, a brief mention must be made of the growing importance of "artificial daylight." There is a range of occupations from cigar-sorting through dyeing to colour-printing where decisions about the colours of materials are all-important. Everyone knows that north skylight, full sunlight, electric light, gas-light have differences of quality which make colours which match under one illuminant appear to differ under another. Dresses bought in daylight may not be so successful under

electric light at night. In colour industries such differences may lead to heavy losses.

The many "daylight lamps" on the market —some good, some bad—all aim at reducing the excess of yellow rays in the spectrum of gas-filled lamps, either by filtering the light through bluish glass, or by reflection from bluish pigments. The result is a source of very low efficiency but giving a quality of light akin to daylight. Colour matches, made under a good artificial daylight produced in this way, can be relied upon to be good matches in real daylight also.

Although these lamps are not used very scientifically yet, it is probable that ten or fifteen years will see the abandonment of real daylight—itself so variable in quality—as the standard illuminant for colour matches. A generation of workers will arise, trained to make their decisions under an artificial daylight carefully screened from all adulterating light. There are so many advantages in a universal standard of intensity and quality for the light used in colour matching that its adoption cannot be far off. The delicate human powers of visual discrimination will then have a chance which is mostly denied to them now.

Noise and Vibration

In the early days of factories, noise was one of the discomforts on which the opposition to

industrial life was chiefly focussed. More pressing troubles followed soon, and have so obsessed us to this present day that as yet no very strong disposition exists to treat noise as a serious evil. There is, moreover, great difficulty about experiment, for the noise of machines cannot be eliminated without stopping them. If they are stopped, work stops too, and there is no possibility of finding relations between noise and efficiency. Laboratory experiments have been recorded, where noise and vibration together killed mice exposed to them, whereas mice exposed to noise alone lead thriving lives; but such results have little industrial value.

On *a priori* grounds noise should be reduced as far as possible. Irregular or interrupted noises are disconcerting to most people and certainly interfere with mental work. Adaptation to regular or continuous noises, on the other hand, is remarkable. But even in such "getting used" to noise, effort may conceivably be needed in the maintenance of indifference, and this effort may prove ultimately to cause fatigue.

Special care should be taken to avoid the performance of stamping, cutting and press work near quieter work like assembly and inspecting. In the case of workers engaged on monotonous work, noise and vibration from other parts of the workroom are sometimes most harassing and objectionable. It is as if

the close focussing of their attention on the work left their senses unbraced against unexpected assaults. Where noise is unavoidable, the real annoyance and suffering that it may cause should at least be confined within limits as narrow as possible.

CHAPTER IV

WORK AND REST

By Rex Knight

ALL work requires rest. Fatigue is the natural outcome of continued activity; and in the end undue fatigue can be removed only by adequate rest. The industrial worker can, of course, ward off fatigue, within limits, by regulating his speed to suit his condition from hour to hour, whereas the sprinter must go on until he drops. Nevertheless, in many factories, fatigue exists which could be reduced by appropriate rest pauses, better methods of work or an improved environment, and this fatigue daily reveals itself both in mental and physical strain and in reduced and inferior output.

Industrial Fatigue

Industrial fatigue affects the worker's muscles, nerves and mind. *Muscular* fatigue supervenes when the active muscle has produced more lactic acid than it can bear. A person's ability to resist muscular fatigue appears to depend mainly on the degree of lactic acid concentration which

his muscles can tolerate, and on the facility with which the lactic acid produced by his muscular activity can be reconverted into glycogen or oxidized. In *nervous* fatigue, although the nerve fibres themselves are virtually indefatigable, the end plate in which each nerve terminates at the muscle fibre becomes unable to transmit from the nerve to the muscle the impulse which alone can initiate activity; and it may well be that the terminations of the nerve at the other end, i.e. in the central nervous system suffer changes allied to fatigue. *Mental* fatigue expresses itself in many different ways. Sometimes the tired mind loses control of its less amiable thoughts and feelings; then things are said and done which had better have been repressed. The fatigue of prolonged concentration often results in worry and irritation. Again, if the task demand too little rather than too much attention, fatigue will be revealed in boredom; and if the waning interest be not revived by a pause or a judicious change of work, it will soon spread from the particular task in question and result in general listlessness and *ennui*.

Although these three kinds of fatigue certainly exist, our knowledge of industrial fatigue is far from complete. It is not a simple quality which it is easy to define and easier to measure. The relations between fatigue and inhibition, between "higher" and "lower" fatigue, and between fatigue induced by repeated acts of attention

and that induced by the effort to sustain an attitude, are difficult to determine; the varying effects of incentive, excitement, nervousness, suggestion and other qualities which affect fatigue are also hard to estimate. Of the effects and accompaniments of industrial fatigue we have considerable evidence, but of its intrinsic nature we know next to nothing.

It follows that the only safe guide in diagnosing fatigue is the work curve—a graph showing the worker's variations in efficiency from week to week, from day to day, or from hour to hour. The so-called "direct" tests of fatigue are of little use. They are all vitiated by the fact that we know so little about the essential nature of fatigue. Not knowing what fatigue is in itself, we cannot know that it is measured by a given test. And even if this fundamental difficulty could be overcome, tests of fatigue would still fail in practice; for their results would always be affected by the changes in emotional tone, in attention and in general attitude, which occur when the worker is withdrawn from his work for the test. We must, then, be content to know fatigue by its effects, and to take the work curve as our index.

How the work curve may be used as an index of fatigue will be described later. First, let us examine the effects of those changes in the distribution of work and rest which have loomed so large in industrial history. The chief of such

changes has affected the number of weekly hours of work rather than the division of the daily work-spell. It will therefore be convenient to discuss changes in the length of the working day before changes in the distribution of the daily hours.

The Length of the Working Week and Day

The length of the working week and the length of the working day may be treated together. Changes in the number of weekly hours have almost invariably been accomplished by changes in the number of daily hours rather than by changes in the number of working days per week. A shorter working week, in other words, has almost always meant a shorter working day. Possibly, a three-day or even a one-day week will be the rule in the distant future; but in 1929 the greater part of industry was still organized on the old five-and-a-half-day or six-day basis (mainly the former), although the five-day week was receiving more serious consideration and was being adopted by a growing number of firms.

As is well enough known, the progressive reduction in working hours, which began with Robert Owen's experiments at the beginning of last century, has not been the result of calm, scientific investigation into the best length for the working week. Legislation affecting hours of work has been introduced at different times since 1802, but the subject has too often been

approached with enthusiasm or alarm rather than with a desire to find out the facts. And with each reduction the opportunity has been missed of studying on a large scale its effect on health and output.*

However, some results of scientific value have been obtained by certain firms (e.g. Messrs. Mather and Platt), by the Health of Munition Workers Committee, by the Industrial Fatigue Research Board, and by the National Institute of Industrial Psychology. The findings of the Health of Munition Workers Committee, to which we shall presently refer, are perhaps the most important, even though the precise hours of work suitable for war time may not be suitable for peace time.† Its investigators had unrivalled opportunities of collecting the relevant data. In one factory employing nearly 10,000 workers, for example, it was possible to record, over a period of two years, the accidents, spoiled work, sickness, absence and output of large groups of men and women performing standard

* It is true that certain "research" reports on the effect of hours on output have been issued by the American National Industrial Conference Board. But the data on which these reports are based are either mere opinions or statistics provided by the management and likely to be affected by the attitude of the informant.

† Whereas in war time every patriotic worker exerts himself to the full, in peace time even the best of patriots reserves some energy for amusements, household duties and hobbies.

operations under conditions which remained constant except for changes in hours.[4]

That the total number of accidents will be less during a shorter working day needs no proof. The interesting point is that there is some evidence that reduced hours also lead to a reduced accident *rate*—to fewer accidents per hour. It is true that reduction in hours apparently decreases the accident rate more among women than among men, and then only when the original hours are extremely long. There is also some reason for supposing that it is the shorter work spell rather than the shorter working day which causes the improvement. Nevertheless, in an engineering factory, accidents among women were three times more numerous on a 12-hour than on a 10-hour day; that is, with the introduction of the 10-hour day, accidents fell by 70 per cent.

So, too, the amount of spoiled work is less when the hours are reduced. A firm which tried to run its mills for fifteen hours a day found that in four months spoiled work had doubled, while output had decreased by 10 per cent. Here also, however, the evidence suggests that the harmful effects of the long hours are due less to the longer working day itself than to the longer work spells which it usually involves.

The relation of hours of work to industrial sickness, and industrial absence in general, raises an obviously important question—the distinc-

tion between the *nominal* hours scheduled and the *actual* hours worked. Actual hours are equivalent to nominal hours *minus* hours lost through sickness, lateness, etc. Now, it has been shown that as nominal hours increase, the proportion of actual to nominal hours decreases, and that if nominal hours be increased above a certain point, even the *number* of actual hours may be reduced. In one instance, though nominal hours were reduced from 63¼ to 54, actual hours fell only from 56 to 51. In another case, when nominal hours were reduced from 62·8 to 56·5, actual hours *rose* from 50·5 to 51·2. In a third case the amount of time lost through sickness was 2·8 per cent. of the 46-hour week; this rose to 3·85 per cent. when the nominal hours were increased to 54, and then fell to 2·77 per cent. when the hours were reduced again to 46.

The effect of changed hours on "lost time" is closely connected with their effect on output. But their effect on output involves a further consideration, for output depends not only on the actual hours of work but also on the *rate* of work. It has been found, however, that within limits the reduction of working hours leads to such an increase in hourly output that daily output is increased. Certain evidence had been collected before 1914. In 1893 Sir William Mather reduced the weekly hours at the Salford Engineering Works from 53 to 48, and careful

records during the year before and after the change showed that total output had slightly increased. In the following year similar results were obtained by H.M. Government when it made an average reduction of 5¾ hours per week at the Woolwich Arsenal and of 2½ hours per week at the Admiralty Dockyards. In 1900, when the nominal daily hours at the Zeiss optical works in Jena were reduced from 9 to 8, other factors being kept constant, the men's hourly piece-rate earnings during the subsequent year were 16·2 per cent. higher than they had been during the year before the change, and the power consumption increased by 12 per cent. So, too, at the Engis Chemical Works at Liège, the reduction of the working day from a 12-hour to a 10-hour basis increased the daily output.

The general conclusions to be drawn from these results were confirmed by the Health of Munition Workers Committee. In the large factory already mentioned, where the weekly hours were at first 74½, then 63½ and later 55½, it was found that after each reduction the speed of production increased. In the operation of turning aluminium fuse bodies (on capstan lathes) the output of nearly 100 experienced women was recorded. When nominal hours were reduced from 74½ to 63½, actual hours fell from 66 to 54·4; but since the hourly output increased by 21 per cent., the total output remained un-

changed. When nominal hours were further reduced to 55½ (and actual hours fell to 47·5) the hourly output increased by 29 per cent. Hence the total output was now 13 per cent. greater than it had been at first, even though the actual hours were now 18½ less. These results may be simply stated thus :

"Nominal" Hours Scheduled.	"Actual" Hours Worked.	Index of Hourly Output.	Weekly Output.	Index of Weekly Output.
74·5	66·0	100	66 × 100 = 6600	100
63·5	54·4	121	54·4 × 121 = 6582	100
55 3	47·5	157	47·5 × 157 = 7458	113

Similar results were obtained from a study of a large group of men engaged in sizing fuse bodies. Though nominal hours were reduced first from 66·7 to 60·2 and then from 60·2 to 55·5, improved time-keeping and increased speed of production resulted in the total output during the 55·5-hour week exceeding the original output by 19 per cent., as shown by the graph on opposite page.

It is not to be expected that when hours are reduced, the hourly output will rise immediately. A period of adaptation must intervene. Often there is no change for several weeks ; in some cases months must elapse before the adaptation (which is mainly unconscious) is complete.

Curiously enough, output adapts itself more quickly when hours are increased than when they are reduced. For this reason overtime may be uneconomic. The hourly output decreases rapidly and tends to remain low even when overtime is no longer in force. In an American

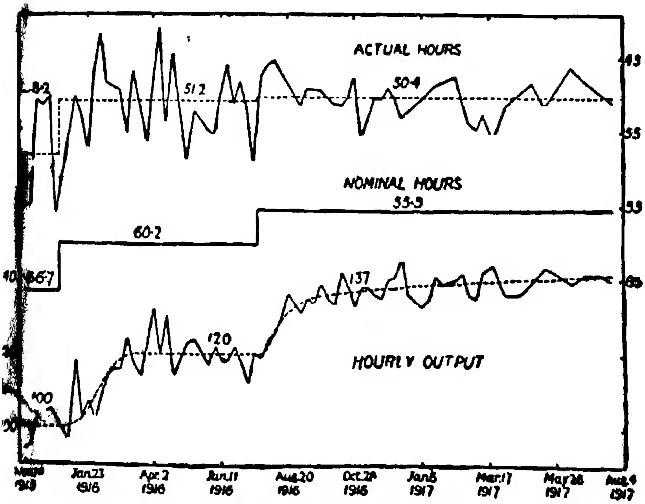

FIG. III.—(H. M. Vernon).

munition plant, for example, when $2\frac{3}{4}$ hours' overtime was added to the normal 10-hour day, the hourly output fell by 6·5 per cent. on the day on which overtime was worked, and by [illegible]·9 per cent. on the following day. Thus, although the labour cost of the day with overtime and the following day was 20 per cent.

higher * than that of two normal days, the output was only 7·3 per cent. more.

After 1918 the Industrial Fatigue Research Board continued the work of Health of Munition Workers Committee. But as the post-war change to a working week of 47 or 48 hours in most industries was accompanied by changes in other conditions of work there was little opportunity of obtaining accurate information about the effect of changes in working hours alone. However, the Board's investigators were able to observe the effects of such changes in *continuous* processes in the iron and steel, tin-plate and glass industries.[5, 6, 7] In these processes the length of shift was changed from 12 hours to 8, and the number of shifts from two to three. The results showed that the change was generally followed by an increase in hourly output. Moreover, although the increase was usually insufficient to render the total output of the 8-hour shift equal to that of the 12-hour shift, there was generally an increase in total output during the 24 hours.†

If, then, we confine ourselves to non-continuous work and remember that the best length of the working day varies for different

* During overtime the rate of payment was increased by 50 per cent.

† Here it may be mentioned that such evidence as there is of the effects of night work (whether continuous or discontinuous) on health and output is highly conflicting.

types of work, the following general conclusions seem to be justified by the existing evidence, part of which has been given here: (i) Every reduction in the working day leads to a decrease in accidents, spoiled work, sickness and absence. (ii) The reduction of working hours from 12 to 10 leads to an increase in hourly and daily output. (iii) The reduction of working hours from 10 to 8 leads to a further increase in hourly and daily output, except in operations whose speed depends mainly on the speed of machines. (iv) The reduction of working hours below 8, though increasing hourly output, does not usually lead to an increase in daily output.

Rest Pauses

It is thus important that the rest between one working day and the next should be sufficient to dissipate fatigue. Equally important are rest pauses *within* the working day. Numerous experiments showing the beneficial effects of pauses during the work spell have been carried out in many countries. In Great Britain, the value of such rests, both for the worker and for industry, has been fully demonstrated by the Industrial Fatigue Research Board and by the National Institute of Industrial Psychology.[8]

The one-break day, which has been adopted by most firms, is usually accompanied by the division of the full working day into two work spells separated by an interval of about one hour

for the midday meal. Usually the number of daily hours is between $8\frac{1}{2}$ and 9, and each spell may vary from 4 to 5 hours according to the distribution adopted. Experience has shown that during these long work spells, rests are invariably taken, whether authorized or not. Not even the most martial discipline can eliminate fatigue or suppress its effects. Experience has also shown that " official " pauses—rests sanctioned by the management—have a far greater recuperative effect than those which the worker must take surreptitiously. It might be thought that the rests which are forced upon the worker by machine breakdowns or inadequate supplies of material should suffice. But such rests often occur when the worker does not desire or need them, so that they lead to worry and annoyance rather than to composure and recuperation. The value of involuntary rests in relieving fatigue is small; investigations suggest that it is only about *one-fifth* as great as that of voluntary rests.*
A worker looks forward to a period which is definitely set aside for rest; and he rests better and works better when others are doing likewise.

How long official rest pauses should be, and when they should be introduced, can be determined only by experiment based on an expert

* "Rest Pauses in Heavy and Moderately Heavy Industrial Work." Industr. Fat. Res. Bd. Report, No. 41, pp. 18–20.

study of the work curve; for, as we have seen, it is in the work curve that indications of fatigue must be sought. If the task be repetitive and the units of output small, a curve showing a worker's variations in efficiency throughout the work spell is easy to construct. Variations in the efficiency of a biscuit-packer, for example, are shown by the variations in the *number* of biscuits he packs during definite periods throughout the spell. But it is sometimes difficult to find a convenient unit for the measurement of output. There is no obvious unit in laundry work, where an ironer may have to treat a wide variety of garments—shirts, tablecloths, dresses, handkerchiefs—which follow one another in no regular order. It is impossible to express variations in efficiency by variations in the number of garments ironed in a given time. To obtain a reliable curve, it may be sufficient to set the ironer a standard task at different times during the day. Standard sets of four shirts could be so intermingled with the other garments that they reached the ironer at definite intervals. Her variations in efficiency might then be expressed by the varying time which she spent on the standard task—that is, by variations in her *speed*. But the conditions of ironing may be such that fatigue will reveal itself less in a slower speed of ironing than in longer intervals between the finishing of one garment and the beginning of the next. It would then be necessary to

measure the variations in the ironer's *unproductive time* throughout the day. Again, it has been found that in ironing the onset of fatigue sometimes causes marked irregularity in output. The ironer may work at a steady rate before fatigue is induced and then become erratic in her output, as she attempts and fails to overcome her tiredness. Here variations in the *regularity* of her output might be measured ; in some cases such variations have been found to serve as reliable indices of fatigue. In still other occupations, where convenient units of output are difficult to find, variations in *power consumption* may fairly represent variations in efficiency.

When a work curve has been constructed by one or other of these methods, it must be duly corrected for all variations resulting from defects in the supply of raw material, machine breakdowns and similar causes. The final curve must represent only those variations in efficiency which are directly due to the worker himself. This curve will vary for different operations and even for the same operation under different conditions. The curve for heavy manual work differs from the curve for light manual work ; the curve for simple repetitive work differs from the curve for work involving more mental activity ; and there are many other differences due either to the nature of the work or to the general conditions under which it is carried on.

Usually, however, the curve will rise at the beginning of the spell as the worker " warms up," and then fall as fatigue is induced. Sometimes the consciousness that his efficiency is becoming less (and the decrease in fatigue resulting from the slower rate of working) will lead to partial recovery followed by a second fall. The curve rises, falls, rises and then falls again. (It is claimed that, in monotonous work, the curve falls as boredom sets in, and then steadily rises again as the worker looks forward to the termination of the spell.)

The rest pause should be introduced at about the time when the output has just reached its maximum. Working activity is then about to decrease; and the pause, by warding off fatigue and other detrimental influences, will tend to maintain output at a high level. For experimental purposes it will be best if only some of the workers are given the pause. Their work curve can then be compared with that of the other workers who have no " official " rest. If all the workers are given a pause at once, the subsequent data may be influenced in an unknown degree by accidental factors (such as alterations in equipment, in material or in other working conditions, or even by an influenza epidemic) as well as by the provision of the rest. Thus the results of the pause will escape exact measurement.

The workers should therefore be divided into

two groups of approximately equal ability; and one group should be given a pause while the other is temporarily treated as a "control" group. (To ensure that the two groups will be about equal in proficiency, the workers may be ranked and then allotted alternately to the first group and the second.) Conditions apart from the rest pause will thus be the same for both groups. It will be necessary, however, to keep the groups apart; otherwise those workers who have been given a rest may tend to regulate their output by unconscious imitation of the others. If the work curve of the group of workers who have been allowed a rest is then of more satisfactory shape, it may be inferred that fatigue has been reduced.

Some irregularities—initial rises and final falls—there will always be; an absolutely flat curve is unobtainable. Nor will the full effects of the rest pause be revealed at once. In an investigation in the assembling of bicycle chains, an increase in output of 18 per cent. was obtained in spite of the fact that the rests occupied 7 per cent. of the working day. But it was only after a period of six months that the girls became completely adapted to the new conditions of work so that the full effects of the pause were made manifest. Similar results were observed in a boot factory and in American metal-working establishments, though the period of adaptation was often shorter. In this respect the workers'

response to rest pauses is similar to their response to alterations in the length of the working day. Only after the lapse of sufficient time for the worker to adapt himself to the changed conditions will the curve assume a better shape and reach a higher level.

The length of rest pauses, no less than their position in the work spell, requires scientific investigation. The most favourable pause will reduce fatigue, boredom and other detrimental factors while at the same time preserving the "warming-up" effect (known as incitement), interest and other beneficial influences. Too long a pause, while reducing fatigue, may dissipate incitement; too short a pause, while preserving incitement, may insufficiently reduce fatigue. It would seem that the rate of restoration of working capacity is greatest in the early stages of the pause and progressively decreases as the rest proceeds. In certain kinds of mental work, rests of 2 minutes after 40 minutes' work in a spell of 1 hour, and of 5 minutes after 80 minutes' work in a spell of 2 hours, were found to be more favourable than longer or shorter pauses. The results of many other experiments support the conclusion that the value of a rest is not proportionate to its length.

In some processes, especially those in which the maximum output is attained early in the spell and followed by a fall, several short rests may be more beneficial than one long

one. In one operation the workers produced 16 pieces per hour when taking spontaneous rests; 18 pieces when working 25 minutes and resting 5; 22 pieces when working 17 minutes and resting 3; and 25 pieces when working 10 minutes and resting 2. In still another investigation it was found that two rests of 5 minutes in a 2½ hours' spell gave almost twice the increase obtained when only one rest of 10 minutes was given. In an embroidery process, on the other hand, it was found that two long pauses were better than three short ones. The pioneer work of Taylor in connection with the handling of pig iron also affords interesting evidence on this point. It is true that his experiments refer to a selected group of workers whose rate of payment was increased; nevertheless they clearly showed that the best distribution of periods of work and rest varied for loads of different sizes. The best number and length of rest pauses must therefore be determined by careful study of the work curve of the process for which they are intended.*

Again, rest pauses vary in their effect upon different individuals. Investigations, both in the factory and in the laboratory, have shown

* There is little scientific evidence as to how the rest periods may best be spent. But it is fairly certain that this depends upon the nature of the previous work. Sedentary workers will benefit by movement and change of posture, while those engaged in heavy manual work should have an opportunity for relaxation.

that while the total output of a few workers may be decreased by the introduction of an official rest, or remain at its previous level, the output of the majority will generally increase. The best rest for any individual worker can be determined only by an analysis of his own particular work curve. It would be found that slightly different distributions of rest and work are best for different workers. But, of course, great practical difficulties would be raised by any such arrangement and the benefits derived from the workers' working and resting together would be lost.

The beneficial effect of rest pauses on health is guaranteed by the fact that they reduce fatigue. But the sickness records in the tapestry works already referred to are worth recording. Here rest pauses were introduced in the embroidery department in July, 1927. "During the five months, August–December, the time lost through sickness was 25 per cent. less than during the same months of 1926. These figures are rendered particularly striking by the fact that a similar comparison made for the rest of the factory show that in all other departments sickness absenteeism was 78 per cent. more frequent during August–December 1927 than during August–December 1926." *

* Bevington (Sheila), Miles (G. H.), and Roberts (Gladys), "An Investigation in a Tapestry Factory," *J. Nat. Inst. Industr. Psychol.*, Vol. iv, No. 8, p. 165.

Effect of Rest Pauses on Output

As regards output, the results obtained from the introduction of rest pauses have shown that in the great majority of cases the total production, as well as the hourly rate of production, has increased. This has been due partly to increased speed of working and partly to reduced unproductive time. The elimination of fatigue enables the workers to attain a higher speed and makes it unnecessary for them to take unauthorized rests.

Rest pauses are particularly beneficial in repetitive, monotonous work. Thus in four typical repetitive processes, increases in output of 13, 5, 8 and 11 per cent. were obtained after the introduction of a rest of 10 minutes at about the middle of the morning work-spell. Processes like the inspection of small articles and telephone work, which, although not monotonous, involve constant attention and a series of volitional acts, also need suitable rests; and operatives engaged in heavy work or in work which demands a continuous sitting or standing posture find rest pauses specially beneficial. Again, in those occupations where the working-rate unavoidably exceeds the natural rhythm of the body, the fatigue thus induced must also be relieved by rests.

The accompanying graph shows the effect of a 15 minutes' rest at 10 a.m. on the speed of

20 girls operating sewing machines in a printing works. The pre-rest curve is based on four

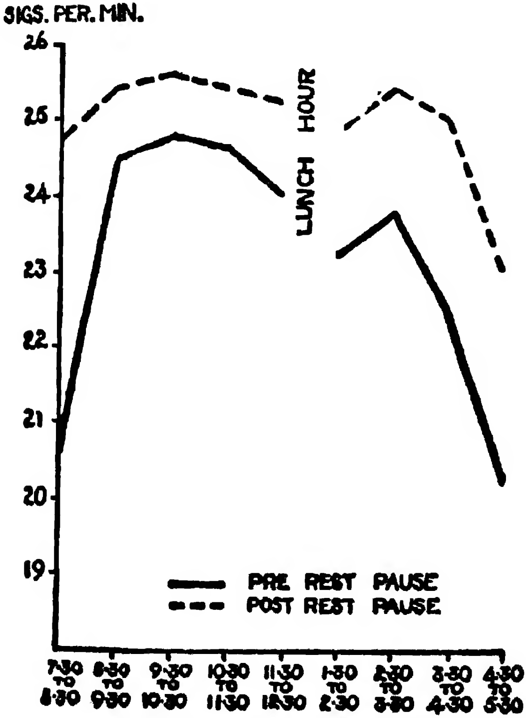

FIG. IV.—(Knight and Raphael).

weeks' records, the post-rest curve on two weeks' records. The rest had to be given to all the girls at once—it was impossible to obtain a "simul-

taneous " comparison by giving the rest only to some of the girls and comparing their work curve with that of the rest.

Rest pauses also frequently improve the quality as well as the quantity of output. In another printing works, for example, where the work done during the last hour of the day had been of little value, the introduction of a 10 minutes' rest in the morning and afternoon led to a marked increase in accuracy. So, too, in the ironing of handkerchiefs it was found that better work was done during the latter part of the day after the introduction of a pause. All these improvements are due to the beneficial effects of the rest pause on the mind and body of the worker. He becomes less fatigued ; and instead of being oppressed with the prospect of 4 or 5 hours' unbroken work, he can look forward to an authorized and welcome rest.

Such difficulties in the introduction of rest pauses as arise from natural conservatism, fixed habits and dislike of innovations can generally be overcome by tact. And to the employer, who, although pleased with an increase in total production, yet grieves over the stoppage of his machines during the rest, a combination of team work with rest pauses may be commended. In the press-room of a boot and shoe factory, an increase in output of almost 50 per cent. was obtained by allotting three girls to presses formerly worked by two, so that each girl rested

for 20 minutes every hour.[6] The girls worked more comfortably and with less fatigue, and the increase in output of 50 per cent. involved only the wages of an extra girl, without any capital outlay or increase in the cost of running the machines. Similar results were obtained in a bottle works, where for presses which had previously employed one man and two boys, additional boys were engaged so that each could work 40 minutes and rest 20.[7] It is also sometimes possible to avoid the stoppage of machinery by running it more slowly and entrusting its supervision to a smaller number of workers while others are resting.

Rest pauses, however, are not the only means of eliminating monotony and fatigue. Sometimes a change of work is equally effective, especially where the work is more monotonous than fatiguing. Music, too, has been found to have a favourable effect in relieving boredom, provided that it is used judiciously and is carefully selected. Care must be taken that music is not played for too long periods, or it loses its effectiveness, becoming part of the general background. Music seems to act as a "tonic," freshening the worker who has become bored by the monotony of a repetitive task. It is not, therefore, an adequate substitute for a rest pause where the work involves muscular fatigue, calling for periodic physical recuperation.

CHAPTER V

EASE AND SPEED OF WORK

By G. H. Miles and A. B. B. Eyre

Time study can be applied on the one hand to the mechanical side, and on the other to the human side of industry. By careful study of the movements and working speeds of a machine, a keen observer can often discover points at which improvements could be introduced. In redesigning the mechanism he will incorporate such changes as will reduce time-losses, thereby rendering attainable increased output. This is essentially work for the engineer. A good illustration of this is provided by the invention of the rotary printing machine, which allows of continuous printing activity in place of the intermittent work of the older type of press.

The human being, however, cannot be redesigned, and improvements in his methods of working can only come about after consideration of the mental and physical principles by which he is governed. In other words, the study of the human side of industry is

the work of the trained physiologist and the psychologist, not of the engineer.

Even the mechanical side of industry is in the end largely dependent on human activity. With all machines there is some pause, the duration of which is determined by the operator. It may be occasioned by the preliminary setting-up, as in the case of the printing press, loom or spinning frame; it may occur in the feeding of new material, as in the metal-stamping press or box-stitching machine; or it may take place in the readjustment of the machine after a breakdown. At each of these points a knowledge of the principles of mental and physical activity is essential if real improvement is to be made. This is obviously a field in which the psychologist and engineer must co-operate.

The human being, however, must not be regarded as a machine. This is a fundamental proposition. Time study and movement study, as carried out by the industrial psychologist, are totally different from time study and movement study carried out by one whose outlook is dominated by a training in engineering. For example, a pause in an operation is, from a mechanical point of view, pure waste of time: and in a machine or in a process, the elimination of this unproductive time would directly increase efficiency. In the case of the human being, however, a pause may be serving an extremely useful recuperative purpose; and though its

elimination might be possible and produce good immediate results, the effect on health and constitution might in the long run prove disastrous.

The efficiency engineer is often able to produce startling results by setting a standard time for a series of operations and by giving the worker a strong bonus incentive, or by using the fear of dismissal, and thus inducing him to accomplish more work in a given time. But such practices are not, in the long run, economic; and they have, in the past, made the workman very suspicious of time study. Men often deliberately go slow when being timed by a rate-setter.

The industrial psychologist's work is sometimes hampered by this attitude, though more generally the reverse attitude is present and his results may be unduly affected by the workers' desire to co-operate. This often results in outputs considerably above normal which in time drop to a steady level. In one case, where records of production were being taken, output increased by over 20 per cent. although no actual change had been made. Such an increase might reasonably be supposed to imply that the workers had been slacking previously; but the hourly output curves showed that this increase was a special spurt due in all probability to the presence of the investigator. When a person realizes that he is being timed, his normal speed will in all probability change. Such obstacles to correct timing may often

require a considerable amount of tact and patience to overcome. Records are of little use until they show conclusively that the subject is acting normally. In both time and movement study therefore the industrial psychologist must be alert to changes in environmental factors.

Time study is useful to the psychologist apart from the information given by the actual records. It serves to concentrate his attention on the important features in the cycle of operations; from such observation he is eventually able to estimate the demands, physical and mental, that are made on the worker at various portions of the cycle. Thus in a certain operation it was thought that parts of the cycle involved undue strain on the operator. But it was only after the operations had been repeatedly timed that it was discovered that the main hindrance to more effective work lay in the need for repeated decisions and choices which, though so small as to be overlooked by ordinary observation, were nevertheless cumulatively responsible for a large part of the mental fatigue which accompanied the day's work.

It will be obvious that for the industrial psychologist the actual events, mental and physical, which occur within a given time are more significant than the elapsed time. Movement study is therefore involved in all time study; in fact time study is of use mainly for obtaining a record of events and for concen-

trating attention on important parts of a cycle of operations.

In modern industry much work is repetitive, though the length of the cycle may vary from a few minutes to several days; and one of the greatest difficulties often lies in determining suitable units for observation and timing. A completed study gives a definite time picture of the duration of the various operations within the cycle, and the industrial psychologist must then determine from this picture what are, from an economic point of view, the parts that are of fundamental importance. Thus it may be found far more important to consider means for reducing the strain imposed on a worker by divided attention or faulty supply of materials at one period of the cycle than, for example, to concentrate on a detailed study of finger movements required at some other part of the cycle.

There is yet another field in which time study can show prospects of useful results both for the employer and the worker. Many processes require the simultaneous activities of a group of workers in order to complete the cycle of operations. In road-repair operations, rail-laying, building, filling gas retorts, tyre-vulcanizing, cable-laying, machine-baking, and in many other occupations, groups of from four to a dozen men are employed. Casual observation soon shows that some have a soft job, whilst others in the same group bear the brunt of the

work. The output of such a group is limited by the capacity of the hardest-worked man. If a better distribution of duties can be made, the strain can be spread and a marked improvement in output will result.

A preliminary time study of each man's activities will soon show the inequalities within the groups. The results for each man can be plotted graphically in proper time sequence, and a close study of the operation will then disclose instances where a redistribution of duties can be arranged. Following this, or perhaps simultaneously with this, movement and position study will give clues for additional improvement. It is often possible to improve working conditions very considerably by spreading out the work and relieving the undue strain which always falls on one or two members of such a group, if they arrange the work themselves in the usual haphazard fashion. In some cases it may be desirable that the hardest-worked member of the group should change places with one whose job is, comparatively speaking, light. Usually it is possible to get a fairly accurate estimate of the most effective length of the work spells and rest spells, if a careful time study of the job has been made.

Movement Study

The objects of movement study have been defined in this way—" to improve those move-

ments of the worker that are necessary for the effective execution of a given operation, and to abolish those that are unnecessary." These are objects of the highest value both to the individual and to the community. Like any other science movement study requires patience, common sense, and, above all, the right point of view. To attain the latter the value of the objects aimed at must be fully grasped at the start.

It may be useful to compare the individuals comprising a workshop personnel to a cricket team. Each member of a cricket eleven is selected with judgment based not merely on the "personal interview" but also on his proved capacity to handle his "tools" effectively. He, for his part, has made the utmost use of instruction and practice; he selects his bat and examines the ground with minutest care: he studies the influence of light and weather.

What an ideal state of affairs we should reach if teams of industrial workers were capable of the same interest and keenness in their jobs, if the individual worker were selected and placed in the field after scientific study of his capacities, and if he were trained in such a way that his movements, his time and his efforts were used with the utmost economy possible! Industrial Psychology is now showing that the gulf between work and play is not unbridgeable.

Rightly viewed, the one best way of performing any process or operation is unattainable except in a relative sense. Let us suppose movement study applied to violin playing. In order to maintain the required balance between grip, poise, strength and lightness, hours of practice are needed every day during a lifetime. Genius has never completely surmounted these difficulties, nor ever will surmount them. To reach a certain degree of perfection involves hard work and struggle. But to maintain consistently that level of performance is impossible ; there will be inevitable lapses. A performer's skill is judged not by the degree of perfection he may attain on certain occasions, but by the average level of excellence which he will show on all occasions. The fact is that in all human actions degrees of skill vary not only between one performer and another but from moment to moment in the case of every individual.

Nor in such a simple case as that of hammering in a nail is there any one best way ; there is always a better and a better way. Between a hundred men there will be a hundred degrees of skill shown, and who shall say that the most expert among them is incapable of improvement in regard to sureness of eye, the most economical "lift" of the hammer, looseness of wrist, position of body, arm and hand, combination of lightness and strength as regards his grip, and so on ?

Practical Directions

In carrying out movement study, the following main points should be observed:

(*i*) *Frequency of Operations.*

It is well first of all to note which are those movements, whether of hands, arms, feet or of the body generally, which are most often repeated in the course of the work. Do not waste time at the start on those operations or processes which are carried out only perhaps a few dozen times a day, when there are others which are repeated many hundreds of times daily. It may be that those that are performed less often are obviously the most fatiguing in themselves; but the lighter operation, repeated ten times to the other's once, is in all probability the most fatiguing in the long run.

(*ii*) *Length of Reach.*

One of the most obvious means of saving time and effort is whenever possible to reduce the distance which a worker has to reach for the articles he is handling. Apart from its effect on the worker's comfort, such reduction is frequently a means of increasing output; yet it seldom receives the attention it deserves.

In assembling, packing, repairing and construction work of all kinds, the worker must reach out his hand for material and tools

hundreds, and very often thousands, of times a day. If these can be brought nearer to him by rearrangement of the articles themselves, by the use of crescent-shaped in place of straight shelves, by altering the height of the bench, or by raising the back part of it, a great deal may be done to relieve strain and to save time. The further the reach, the greater in proportion is the strain on the muscles and the amount of body movement involved. It is during the latter hours of the day that these little extra efforts repeated many times over begin to have their effect.

Appearances are often very deceptive. The man does not *appear* to be in trouble, he has only to take a step or two to get at everything he wants. He is a good worker; he does not complain; his output is fairly satisfactory. Why worry? The man himself probably never suspects that he is at work under any difficulties; he has become accustomed to his conditions, having arranged matters according to his likes, as far as lay in his power, when he first took over the job. But it is one of the first duties of the industrial psychologist to put himself in the other fellow's place; to see what the man needs, to ascertain where he is wasting his efforts, even when he himself does not realize this need or waste.

These remarks apply equally to the apparently small matters and to the more obviously

important ones. It is the greatest mistake to regard anything as too small to be "studied." A tool-rack placed a foot beyond a man's reach is obviously in the wrong place. Even when it is reasonably near to him, he may have to stretch an inch further than is really necessary in order to reach it. It is not the foot but the inch that requires thought. In this case an inch is *not* the twelfth of a foot; it is very much more than that, for that inch comes *at the end of the man's reach.* It may make all the difference in the use to which the rack is put. In innumerable cases where there has been no consideration of the matter the slight extra effort has perforce to be repeated hundreds of times daily. The effect on the man is cumulative, and adds to the total fatigue towards the end of the day.

(iii) Arrangement of Material.

The question of "where" in regard to everything handled by the worker needs the closest attention. In a previous section we have spoken of the importance of his having everything within as easy reach as possible. This is a factor in the arrangement of material that concerns his physical rather than his mental well-being. But his knowledge on every occasion precisely where to put his hand on any article is a matter of far greater significance for him than the distance through which his hand, or his body, has to travel

for it. The more repetitive his work happens to be, the more important does this question become.

The time lost in looking for articles is a serious matter to the worker; economists will make it 'ear how he stands to lose in every way as 'yards waste of time. And yet when the matter is looked into more closely, it will be seen that the time element is the least important factor. If a worker is interrupted, say, twice a day for ten minutes by having to search for some tool, whatever it may be, he loses both time and temper, and is a sadder man in consequence. And if those twenty minutes lost out of his working day are the sum-total of many little delays of seconds only, the results so far as he is concerned will be far more serious. His smooth working, his "rhythm," is being constantly interrupted; and each time this happens his efficiency is to a slight extent impaired. He is thus left unduly tired at the end of the day, whereas the same amount of effort put into smooth work would have resulted in more output at a cost of less fatigue. There is all the difference in the world between the healthy tiredness that comes from work and that other unhealthy kind which results from irritation and annoyance.

Tools that are on the bench instead of in a rack not only cause time to be wasted and effort expended in looking for them among the litter, but they add also very considerably to the time and energy needed to clear the bench at frequent

intervals throughout the day when space is needed to work on. In a cabinet-makers' shop twenty-three minutes were lost in an eight-hour day by these means. After tool racks and shelves for planes and saws had been provided, these twenty-three minutes were reduced to three minutes.

Another instance is afforded by girls packing chocolates. The different varieties had been placed along the shelves in haphazard fashion. The arrangement was then so standardized that the girls knew exactly where to find each type and could pick up the chocolates with both hands. As a result, they saved on the average one hour and forty minutes out of an eight-hour working day.

In the early part of the day petty distractions and delays do not count for much; but towards the latter part they become maddening by their insistence. It is a point well worth remembering, where repetitive work is concerned, that distractions which are of the *same* nature or come from the *same* cause have a far more wearing effect on the mind, than those which may occur equally often, but arise from *different* causes.

The worker generally "arranges" material for himself, so far as lies in his power; but he needs assistance, and that (for various reasons) is not so often forthcoming as it might be. The parts to be assembled, the tools to be used, or the articles to be packed need shelves, tool-racks, boxes,

pigeon-holes, drawers, etc., with partitions or similar aids, in order that they may be kept always in certain specified places. These matters have first of all to be thought out, experimented with, standardized, fixed up, and then paid for. On the part of someone, therefore, experience, time, mental effort, money and authority are called for.

(*iv*) *Bi-manual Work.*

If both hands are used simultaneously in performing identical operations, the work is done with a saving of about 30 per cent. of effort, by the co-ordination of muscles acting in conjunction from both sides of the body. This fact should be taken advantage of whenever possible. It is not to be applied only in lifting or carrying heavy weights; in repetitive work, whenever both hands and arms can be conveniently employed for the same action, the saving in effort and time will be valuable.

(*v*) *Speed, Direction and Rhythm of Movement.*

Successive movements should pass easily from one to the other. Where difficult work is in question, requiring very accurate movements and judgments, slow work at the start will in the long run increase efficiency more quickly than any other method. "Slow and sure" is more easily preached than practised; but in the end it is economical of movement, time and energy. This

rule applies to every learner and it should be considered also, and cautiously inculcated, in those cases where a worker has had time and opportunity to learn his job but where his work is not satisfactory.

Rhythm undoubtedly gives rise to pleasant feeling, as can be seen most conspicuously in dancing. A number of experiments have been recently carried out in sweet-dipping and coal-mining, where rhythmical activity has led to marked increases in output. The coal-miners, for example, were trained to wield the pick, whenever possible, in a continuous curved path instead of in jerky up-and-down strokes. The best rates of picking for different types of material were also determined. When once the difficulties of adaptation were overcome, the men expressed themselves highly satisfied with the new method, and their output, as shown by the figure opposite, increased by about 16 per cent In general an easy change of direction and velocity is far better than direct, straight-line movements. Thus if an operation requires that a worker's hand moves in succession to the three points of a triangle, a longer curved movement which takes in all these points is easier and far less fatiguing than a direct rectilinear path from point to point.

In some branches of industry the job may involve larger bodily movements of a rhythmical character. Here much satisfaction can be gained,

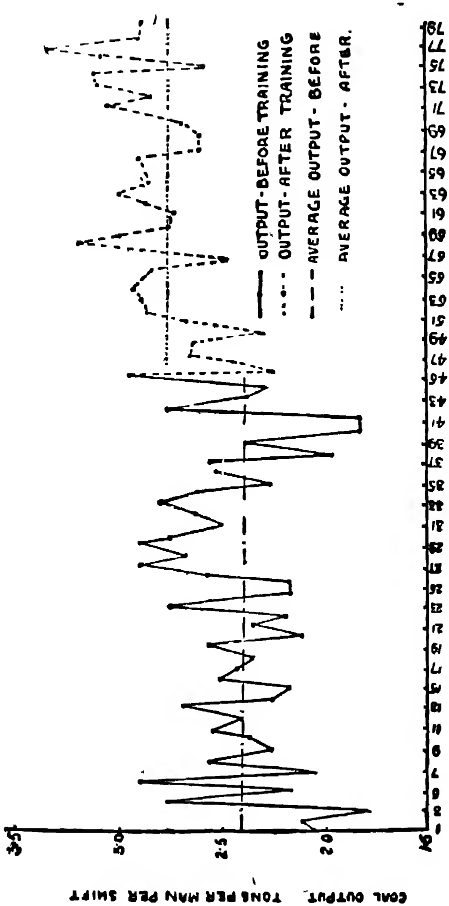

FIG. V.—(Farmer, Adams and Stephenson).

with a corresponding reduction of fatigue, if such movements are gracefully combined with body balance. This shows itself in a neatness and deftness of execution that mark the highest form of skill. In one large laundry the girls working on the calender in pairs had acquired such a degree of rhythm and balance in their movements that the otherwise prosaic job of feeding sheets and table-cloths into the machine became quite interesting to watch and to carry out, and was evidently much less fatiguing than the awkward, erratic movements frequently adopted at this work.

How close is the relation between fatigue and bad methods of work is shown in the following graph, which gives the average daily output of four workers in a boot-and-shoe factory over a period of from four to five months. The curve of the most skilled worker will be seen to rise throughout the week ; whereas the curves of the poorer workers reach their highest point on Wednesday and afterwards show a marked " fatigue " effect.

The Limits of Standardization

Yet another group of problems awaiting further research is concerned with what is sometimes called the "natural rhythm" of the worker. Common observation shows that each person when not under pressure writes, speaks and walks at a certain fairly constant rate, and

recent experimental work has suggested that there is for each person a normal and definite rate of activity. Link, in experimenting on a

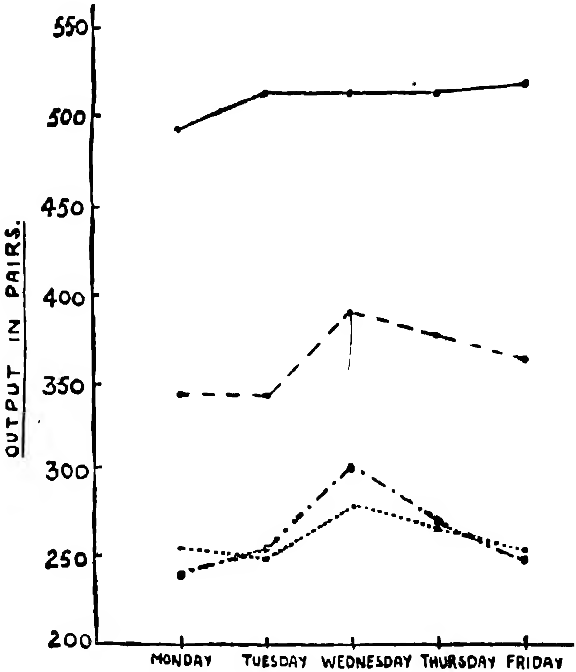

FIG. VI.—(Loveday and Munro).

number of persons engaged in munition work, found that there were distinct groups—one fitted for the control of quickly moving machinery and another which could more effectively control

slowly moving machinery. This is also borne out by experience in industry; a man may be an excellent worker on one type of machine and no good at all on another. It is evident that the rapidity of recurrence of the cycle of operations in a job and the worker's natural ability to fit in with this rate are likely to be important factors in reducing to a minimum the waste of physical and mental energy. There are quite a number of interesting factors which serve to emphasize the vast difference between the routine activity of the human being and that of a machine. Sometimes the movements of the practised workers are so quick that ordinary observation fails to note many of the essentials, and in such a case the use of the cinema camera will often give a clue to the movements. Some remarkable results have been obtained by F. and L. Gilbreth by the application of such a method. Indeed they have carried the work to a high degree of refinement by photographically determining the velocity at different parts of a complex movement and by constructing models of the path traced out by the hand or other parts of the worker's body. It is often of a great advantage to project cinematographic pictures slowly so as to determine just what factors give the key to success. But unfortunately an attempt has been made to standardize the movements of the workers and to fix what is known as the "one best way" of working. This phrase is an excellent slogan and

appeals to a certain type of manager, but unfortunately it does not agree with ascertained physiological and psychological facts. The ' musculature " of no two persons is identical and on the mental side there is equal divergence ; any attempt to train men to work in precisely the same way is doomed to failure in the long run, unless enforced by a discipline far too rigid for industrial life. It may be argued that in military and gymnastic displays there is identity of action, but to a close observer this is far from being the case. In industrial work such rigidity is entirely out of place, and if it is enforced by the operation of strong bonuses, incentives or other means, the worker feels that he is cramped or even enslaved.

High production can be and has been forced in this way, but at too great a cost. It is far preferable to train the workers in broad general principles and to help in the discovery of the best method of work for each individual worker in accordance with his mental and physical make-up. The psychologist realizes the advantages of eliminating wasteful and bad ways of working, but he objects strongly to attempts to standardize industrial activities too rigidly. He readily agrees with the engineer that from a mechanical standpoint there is often one best way of, say, assembling a clock or a magneto. But to carry over this idea to the minute movements of the workers is contrary to all human considerations.

The psychological effect of restriction of a worker's activities is still not sufficiently realized. There is in all animals—and the human species is no exception—a tendency to resist limitations of activity. Pavlov refers to this as the "freedom reflex." It is so powerful that on occasions the animal will resist with the utmost energy, to the point of complete exhaustion, attempts to restrict its activities unduly. Its activity can however, be greatly modified by the action of other incentives.

There are in industry many occupations where normal human activities must be largely restricted throughout the working day. Incentives in the form of high pay and bonuses will largely modify any reaction to such restrictions as are voluntarily accepted by the workers. When, however, a succession of irksome restrictions is added, when the worker is repeatedly time-studied, or is forced to work in the so-called "one best way"—when, in other words, government from without begins to dominate and the incentive of extra pay is reduced by a cutting or tightening-up of rates—a point is reached at which the reaction to restriction asserts itself with almost primitive force. Output gained by these methods is obtained at a terrible cost of human energy and happiness; by substituting compulsion for co-operation it threatens the whole security of the industrial system.

Evidently it is essential to ascertain with the

greatest care whether a change in method is of real advantage to the worker. An increased output is comparatively easy to attain over a short period. This can be accomplished by a sufficiently attractive bonus, by a fear incentive or by a desire on the part of the worker to co-operate. Given a sufficient incentive, the human being is always capable of an additional spurt of activity above normal, for a period sometimes of considerable extent.

It is therefore essential to ascertain if the increased output which follows any change in the method of working is due to a reduction of effort per unit produced, or is being attained as the result of an undue expenditure of energy. Here further time study and a comparison of the work curves with those obtained before the alteration will often give an indication of the true value of the new method.

CHAPTER VI

UNPRODUCTIVE WORKING TIME

By A. Angles

Extent and General Causes

In any type of factory it will be usually found that a high proportion of the working day is spent on unproductive tasks. Examples of such tasks are the fetching of raw material, the delivery of finished goods, the waiting or searching for tools, consultations with the foreman, setters-up or other workers, and so on. These tasks are necessarily incidental to the main job and thus cannot be disposed of entirely. But the question may fairly be asked—what proportion of time spent in this fashion should be considered as excessive ?

An article on this subject contains the following relevant passage: "Although the loss of time spent on unproductive tasks on each occasion was small, a careful time analysis showed that the cumulative loss was often considerable." * In three extreme cases as

* "Investigations by the Institute into Unproductive Time," *J. Nat. Inst. Industr. Psychol.*, Vol. iii, No. 5, p. 242.

much as 52, 49 and 44 per cent. of the whole working day were regularly occupied with incidental matters, and the average amount of unproductive time in all the cases studied in the article just mentioned (which covered both hand and machine work) was over 28 per cent. of the total working time.

Two specific instances will serve to illustrate how this lost time occurred. The figures express the unproductive times as percentages of the total times worked.

Causes of Unproductive Time.	Hand Work.	Machine Work.
Collecting materials . . .	23·9	10·91
Delivering finished goods . .	4·3	—
Sharpening or preparing tools .	3·0	13·20
Consultations	—	6·15
	31·2	30·26

In both cases the analysis not only shows that over 30 per cent. of the working day (or nearly 2½ hours) was unproductive, but also at what points time was lost. In neither instance did the management realize how great was the sum-total of unproductive time, nor at what points and with what frequency it occurred. Thus the value of the analytical method is obvious in revealing the true state of affairs. In the absence of such a methodical procedure one is more likely to be impressed by the 70 per cent. of the time that the machine is actually producing, than by the 30 per cent.

of the time spent otherwise,—especially as the latter sum is made up of irregular pauses in production.

The causes already mentioned are simple and to a great extent common to all manufacture. They may be complicated by special circumstances, such as the design and accommodation of the particular factory. For example, excessive time spent in the fetching of raw materials may be caused by a bad layout of the department, or by defective coordination between one department and another. Again it may be due to structural arrangements, raw material, for example, being stored on a different floor from that on which it is subjected to manufacture. Or it may be due to faulty design or shortage of transport media such as conveyors, trucks, cans, boxes or lifts.

Waiting for tools may be attributable to the provision of an insufficient number of them by the firm (this is surprisingly common). The time lost in searching for tools may be largely due to the unsystematic way in which they are put down by the workman after use. Or the bench itself may be of poor design and may not readily permit of the tools being placed in good order. Hence the improved arrangement of material, tools and benches plays a most important part in the elimination of unproductive time. Such changes are

especially valuable in all forms of packing and assembly work.

Excessive time spent in consultation with the foreman may be primarily due to the increasing inefficiency of worn-out machinery. Undue delays under this head may be also caused by the foreman's inability to plan his duties with due regard for the priority of urgent matters. Or the workman himself may be at fault, not giving ample notice to the foreman of matters for discussion which could have been foreseen.

Each of these matters may be small in itself, and hitherto they may have been accepted as inherent and unavoidable delays in the total time spent on the job. But their cumulative effect is such that it reveals the importance of reducing unproductive time as much as possible. The economic advantage of such reduction is obviously a gain both to workman and to employer—to the former by an increase in earning capacity in return for his increased output, and to the latter by a greater production for the same overhead costs. And it is quite possible to achieve this desirable end without "speeding up" the worker.

Careful study of the work curve (which is described in Chapter IV) provides against the danger of over-strain, by the provision of suitable rest pauses and change of work where necessary. These adjustments are to the

workers' benefit; and the consequent result of more work with the same or even less fatigue thus rests on the intelligent application of scientific methods. These methods involve measurement and comparison. The measuring instrument employed in the estimation of unproductive time is the stop-watch. It is extremely unfortunate that this instrument should have been used in the past in such a way as to arouse antagonism to its present employment in the workshop. It has been furtively introduced by the management as an indirect means of destroying piece-rate wage agreements, to the workers' disadvantage. The stop-watch must always be used frankly and openly and with the workers' consent In no instance in the wide experience of the National Institute of Industrial Psychology has this consent been withheld when the scientific object of time study has been explained, such explanation being supported by a fair and square guarantee from the employer to the worker that piece-rates will not be reduced as a sequel to the use of the stop-watch. Such initial co-operation on the part of the worker is not only valuable but essential if the full benefits of time study are to be gained.

If the economic loss arising from unproductive time in the factory is well marked, not less important are its adverse psychological effects. The phrase " production rests on good-

will" sounds like a platitude in these days of popular preaching, but it happens to be true, and is nowhere truer than in the present instance. So long as men are men and not machines, their productivity will be influenced by the working conditions which affect their goodwill.

For example, it becomes particularly irritating to a keen piece-worker when he is kept waiting for the raw materials of his job. Naturally he likes to feel that the way is all clear for "full steam ahead." If this desire is baulked, then he is gradually changed from a good workman to a grumbler, and as he in turn affects others the "morale" of the whole shop is ultimately lowered. If no permanent remedy for this complaint is soon found, a more or less unconscious slowing down of the work and a deterioration of its quality are almost inevitable. In any event a decrease in skill and a dislocation of natural rhythm arise from the repeated interruptions to continuous work.

The lack of a sufficient number of tools also acts as an irritant; and the firm's fanciced economy in such a matter is not only expensive of time in the long run but also encourages the workers' disrespect towards the firm. The general effect of any or a combination of such factors as these is not a sudden revolt, but rather a gradual lowering of the "tone" of

the workshop. "Keenness" is ousted by "slackness," and such general dissatisfaction arises that the unproductive times become lengthened and the productive periods are less productive than of old.

Such hindrances to output are not always easy to remedy; but the necessity is a very real one, if the factory as a whole is to be worked on a happy, and consequently on a sound basis.

The Machine Factor

So far the importance of this subject has been illustrated mainly in its relation to the fetching and carrying of materials and to workshop relations, with but slight reference to machines. The tendency of modern industry is towards an ever-increasing subdivision of task, and this has been made possible by the invention of more and more machinery. The craftsmanship and the hard-won general skill of the post are less in demand, as it becomes rarer for any one worker to fashion a complete article. Thus the influence of the machine is of ever-increasing importance in the life of the worker.

From a mechanical standpoint machines are usually well designed. On the other hand, there is too often little or no consideration of their suitability to the person who will mind them. The attitude of an engineer towards a

machine working under laboratory tests is very different from that of the worker who has to mind it for eight hours a day, week in week out, and who soon discovers its capacity for producing undue fatigue.

The history of the bicycle is useful as an illustration of the development of machines from the standpoint of their saving of fatigue. Legros and Weston show how the bicycle "has been successively modified, first mechanically, so as to obtain high efficiency, then psychologically, so as to reduce the risk of falling and the difficulty of balance, and finally, physiologically, so as to reduce vibration and to enable the force exerted by the rider to be more efficiently applied." * The necessity for corresponding improvements in industrial machinery, particularly in laundry, leather, tobacco and textile trades, is emphasized in their report. We may therefore examine the question—what are the common faults in machine design from the human point of view?

The height of machines is primarily important. They are frequently either too high or too low for the average worker; and when the machine is a cast-iron structure, the fault is not easy to remedy. Even the provision of an operator's platform, which immediately suggests itself as a remedy for too high a

* "On the Design of Machinery in Relation to the Operator," Industr. Fat. Res. Bd., Report No. 36, p. 30.

machine, entails extra risk for the worker, and when the machine is too low for the worker, the difficulty of adjustment is greater. Another common fault is the lack of suitable storage space provided either on or round about the machines. For example, one frequently finds presses so steeply tilted from the front (or working position) as to leave only a small storage space between the back of the machine and the floor. Consequently the finished article is precipitated to ground level, which compels the worker repeatedly to stoop down in order to retrieve it.

Left-handed control of machines is not so infrequent as one might imagine. This obviously involves awkward movement for the average right-handed person. Badly placed foot-levers are a common source of undue strain. They are frequently so placed that only the right foot can be used, thus preventing a change to the left which would give the necessary rest. It would surely surprise the designers of such an error to be told that pressing with one foot may become so habitual an action that the pressing movement is sometimes unconsciously continued by the girl when she has left the machine and is seated in the canteen! Again, foot pedals are commonly made so narrow as to allow of only the tip of the shoe resting thereon, or what is worse, the narrow heel of a Louis shoe.

In an article relating to a factory in which the present writer carried out an investigation, instances are given of twelve modifications which were introduced in machines with beneficial results.* Some of these will usefully illustrate the present subject.

For example, the foot lever of a clamping machine was elevated to prevent uncomfortable leg-stretching, and a heavy spring was moved to a new position. In addition, a support was shortened so as to save space and permit of more storage room for raw materials. The working position of tools was rearranged so that the necessity of lifting a heavy tool hundreds of times a day was eliminated. A net increase of output of 11 per cent. was the ultimate result of these changes.

In another case, owing to the faulty design of the roof of a hot-air dryer, the temperature at the working point was from 95° to 112° F. The two girls working at this point naturally complained of the humid tropical conditions prevailing. A double conical roof was installed and a fan was suitably placed, which immediately reduced the temperature at the working point by 30° F. Even then it was necessary to handle articles at a surface temperature of

* Miles, G. H. and Angles, A., "Psychology and Machine Design," *J. Nat. Inst. Industr. Psychol.*, Vol. iii, No. 3, pp. 159–61.

90° F., which produced blistered fingers; the provision of gloves afforded no lasting protection. Eventually it was found possible to redesign the machine so that it became automatically self-stripping, delivering its goods by a conveyor band on which they cooled as they were carried to a working position at normal temperature in the middle of the workshop. The result of these changes was that a job which had formerly been the most disliked in the workshop was now one of the most pleasant.

Until such time as designers work in unison with psychologists and physiologists, much can be done to reduce the ill-effects of some existing machines by careful investigation along the above-mentioned lines, and by alterations on strictly psycho-physiological principles. The annual "Motor Show" affords striking examples of continuous improvements in a machine mainly devised for use in leisure time. It is surely not less important that machines intended for the gaining of a livelihood should be designed to produce a minimum of fatigue. Awkward working is always wasteful both of energy and of time, and it requires little imagination to picture the benefits which would accrue to all parties in industry if machines were designed to satisfy the physiological and psychological requirements of those who have to operate them.

Factory Layout and Working Methods

So far we have considered how unproductive time is caused by factors in the immediate surroundings of the workman, viz. the supply and disposal of raw material and finished goods, the arrangement of the worker's bench, and the construction of his machine.

We must now consider his relation to the factory as a whole. When we speak of a factory it may mean any type of building from a small workshop to an immense organization employing thousands of persons. And the internal routing arrangements will be just as variable, from awkward communications in an aggregation of linked-up buildings only comparable in complexity to a rabbit warren, to an extensive modern one-story factory with an ideal layout.

In an old factory the major problem in the elimination of unproductive time is largely concerned with effective planning and co-ordination between one department and another. Here the time spent in transporting material may exceed the time spent in actual manufacture, and the workman becomes largely a victim of environmental conditions beyond his control. The remedy clearly depends on intelligent adaptation by the employer. It would be easy to advocate a clean-sweep policy, but such a course would be impossibly

extravagant in these days. Careful analysis usually reveals the possibility of compromise, by means of the re-grouping of departments according to a more logical sequence, having due regard to the human element involved.

Thus we see that the problem of the reduction of unproductive time has both general and local factors. But even when all the points which we have discussed are set right, there still remain the actual *methods* of working. Bad methods of work are a potent cause of unproductive time. The importance of the study of the worker's movements and of his training in good methods of work have already been discussed in Chapter V.

It may here be pointed out that a change from a bad method of work to a good method is often accompanied at first by a *decrease* in output, and not by an immediate increase as one would have hoped. This is because the bad way has at least the merit of having become familiar through years of practice, and the new method slows down the actual pace of work owing to the necessity for constant attention until it is thoroughly mastered. The new method may even *seem* harder because a new set of muscles are brought into action, as for example when a girl is taught to pack articles into boxes with *both* hands, instead of with the right hand only.

The value of the new methods is established

only when an increase of output is accompanied by a satisfactory form of work curve. If there is any departure from this form after sufficient time has been allowed for practice, then the new method is not conducive to the true welfare of the worker and must be abandoned.

These illustrations will suffice to show not only how wide is the scope of this subject, but also how beneficial are the effects to be gained both by employer and by workman if efforts are made to reduce unproductive working time along the strictly psycho-physiological lines adopted by the industrial psychologist.

CHAPTER VII

INDUSTRIAL ACCIDENTS

By A. Stephenson

Both employer and employee are so intent on production that accidents in industry are liable to be regarded simply as accidents, that is, as unforeseen occurrences and therefore unpreventable. The result of accidents may merely be spoiled work; in so far as they may result in bodily injury to workpeople, legislation has proved necessary to coerce both employer and employee into adopting certain safeguards. In spite of this, 843 fatal and 148,853 non-fatal accidents, causing disablement for three days or more, occurred during 1935 in factories and workshops in Great Britain; and 900 fatal and 138,831 non-fatal accidents, causing disablement for a like period, occurred during the same year in coal-mines and quarries. Further, it has been computed that 1,400,000 minor accidents were incurred in Great Britain in 1920, so that there are good and sufficient reasons on both humanitarian and economic grounds for devoting serious consideration to

the problems of accident causation and prevention.

The suffering entailed cannot be measured, but the concrete costs of accidents impose a serious burden on industry. Under the Workmen's Compensation Acts (1906 and 1923) and the Employers' Liability Act (1880), the amount paid in compensation for the year 1935 in Great Britain was over five-and-a-half million pounds. This by no means represents the *total* charge on industry, for it does not include administrative, legal, and medical expenses. To this must be added the costs payable by the employer on account of diminished production, damaged material and machinery, cost of engaging and training new employees; and those payable by the worker, such as reduced earning capacity after an accident, and its effect on the domestic circle. It has been estimated that compensation liability is approximately only one-sixth of the total cost of the accidents in many industries. Looked at in another way, it has been estimated that all the accidents incurred in the United States in 1919 represent a loss in *future* production equivalent to 296,000,000 worker days.

The foregoing items convey incomplete information concerning the effects of accidents, and give no indication of their causes. An important characteristic of any accident, however, is that the seriousness of the effect cannot be measured by the cause. Trifling causes may produce

disastrous results, as for example in an explosives factory, while "lucky escapes" and instances of "getting off lightly" occur when catastrophes appear inevitable in view of the magnitude or nature of the causes. Hence for certain purposes the effects of accidents may be left out of consideration when studying their cause. *Accident Frequency*, that is, the number of accidents occurring in a given time for a certain number of workers, is used as a measure of the seriousness of the causes. For instance, suppose 500 accidents occurred during the year in a plant employing 1,000 men. The frequency could be given as 500 accidents per thousand per annum; or, supposing 11 shifts per week are worked for 51 weeks during the year, the frequency is 500 accidents per 561,000 worker shifts, or 89 per 100,000 worker shifts. To allow for comparisons when variations occur in the length of the shift, the frequency may be given as so many accidents per thousand (or 10,000) hours' exposure (to the risk of accident). Using the example given, the frequency is 500 accidents for ($51 \times 48 \times 1{,}000$) hours' exposure (assuming a 48-hour week) or $\frac{500}{51 \times 48} = \cdot 204$ per thousand hours.

Other terms employed in the investigation of accident causation are *Accident Proneness* and *Accident Liability*. *Accident Proneness* means some personal peculiarity which causes the

individual possessing it to be susceptible to accidents. *Accident Liability* depends not merely on the personal factor but on *all* the factors contributing to accident frequency, and is therefore generally high in dangerous trades. A worker with a low degree of proneness may have a low degree of accident liability even in a dangerous trade, but it will necessarily be higher than the liability of a worker of equal proneness in a relatively safe industry.

To estimate the *effects* of accidents the measure known as *Accident Severity* is used. Briefly, it may be described as the relation of *time loss* on account of accidents to the time worked. During a year, for example, a thousand men in a plant may work 300 days of 10 hours each, so that the total working time is 3,000,000 hours. If, during this period, 30,000 working days are lost on account of accidents, the severity rate would be given as 10 days per thousand hours worked.

Although severity rates give a measure of the relative seriousness and economic effects which mere enumeration by frequency rates does not, it must not be overlooked that severity rates do not measure *all* the effects of accidents. Neither accident frequency nor severity rate is a cause or cure; they are simply methods of recording. Nevertheless, analysis of frequency rates is a fruitful field of research in arriving at possible causes. The only certain method

of prevention of the effects is removal of the causes. To accomplish this, in the first place their nature must be known, and secondly suitable antidotes must be discovered. The pronouncement by reliable experts at a conference summoned by the Secretary of Labour in the United States that 85 per cent. of industrial accidents are preventable is at least an indication that much remains to be done.

While the purpose of this chapter is to assess the bearing of Industrial Psychology on accident causation and prevention, other aspects of the problem must incidentally be indicated.

Physical Causes and Engineering Revision

In the march of progress man has gradually obtained control over the forces of Nature to a remarkable degree, and has harnessed or arrested them in the service of industry. To this new industrial environment, natural man has to adapt himself or else suffer by his inability to do so. In our present state of knowledge, some occurrences cannot be anticipated and therefore cannot be controlled. When accidents result in such cases, man contributes little but his presence, so that the cause is relatively simple and is physical in nature. This type of cause is exemplified in the mining industry, in which the fatal accidents in Great Britain are as numerous as in all other industries

together. One great factor, then, in accident causation may be briefly stated as *insufficient knowledge of the physical forces at work or of the means to counteract them so far as they contribute to accident liability.* Detailed enquiry into every serious accident adds something to our knowledge of the causes, and it subsequently yields further information regarding the methods which should be adopted to obviate them.

Primarily the object of all industrial machinery and processes is production; and consequently machine design has been largely subordinated to this object. If the object of the designer were to devise an accident-proof machine, he might succeed at considerable cost to production. To incorporate maximum production and freedom from accidents should be the end in machine design, but this would involve a knowledge of "human material" by the engineers concerned. The position of operating levers, for example, may fulfil all mechanical requirements and yet add considerably to the risk of the operative. In such cases, the hazards are inherent in the machine, and fundamental alteration of design is required. Such fundamental changes in structure, layout, or operating practice are known as *engineering revision.* An easily understood example is the automatic machine which reduces the number of men necessary to turn out any given amount of work, so that fewer men are exposed to accident risks. A theory

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has recently been advanced that a marked reduction of *serious* accidents can only be effected through engineering revision, and this appears to be a reasonable contention so far as those industries are concerned in which the liability to accidents is high. Nevertheless, it should be borne in mind that engineering revision can apply only to those accidents which involve machinery or plant, and that the term can be applied only to the elimination of the underlying causes of accidents and not to the covering up of danger-points.

Adaptability

Such progress has been made in the application of mechanical safeguards that it is estimated that only about one-third of industrial accidents are attributable to machinery, and that not more than one-third of these are due to the absence of guards. By subtraction it is evident that two-thirds of industrial accidents are *not* attributable to machinery, and that two-thirds of those that are so attributable are *not* due to the absence of mechanical safeguards. In all, this means that nearly 90 per cent. of industrial accidents are to be accounted for in some other way. Some are referable to hazards which are inherent in industry. This is particularly the case in dangerous trades, in which accidents are less under the control of the individual who sustains an injury than is the case in less

dangerous occupations. The greatest progress may be expected here from engineering revision, which, as we have seen, signifies the adaptation of the physical factor to the limitations of the human factor.

A large proportion of the 90 per cent., however, is accountable to *inadaptability* on the part of the worker. This failure on the part of the human factor may be due to ignorance because of inexperience, or to his failure to apply knowledge which is available; or it may be due to lack of knowledge regarding the environment or regarding the worker. So many factors may contribute to the causation of an accident that a simple cause can seldom be attributed. This fact is liable to be overlooked in the classifications found in industrial records. It is useful to consider most accidents as being of the nature of a collision; that is, the physical component comes into contact with the human component, with injury certainly to the latter, perhaps to both. When the human contribution consists only in the presence of the worker, it might appear that a purely physical explanation might suffice. Further investigation, however, might reveal that human neglect in a previous process was fundamentally responsible, or that a foreman or supervisor had failed to report some defect.

Even where mechanical safeguarding is as nearly perfect as human ingenuity has been able to make it, instances of apparent fool-

hardiness occur, which make such safeguards ineffective. It is a question whether machine designers are able to appreciate the handicap which some mechanical safeguards impose on the worker, and this may be the reason why they prove abortive in certain instances. Nevertheless, such safeguarding of danger-points and the adoption of protective devices are very important contributions to accident prevention. They represent the attempt to adapt the mechanical factor to the known limitations of the human factor, and until more satisfactory devices are available, foremen can contribute enormously to their effectiveness by insisting on their use, and by reporting immediately any that are defective. How often has one seen protective clothing provided, but not in use; exhaust systems, installed to remove harmful fumes or dust, stuffed with rag or paper; protective goggles cast aside, and frequently unfit for use. To consider one instance only—the provision and wearing of goggles; it is clear that eye injuries are second in seriousness only to death. Artificial legs, arms and hands, although a serious handicap, can do much that the corresponding human members can do; but an artificial eye that will *see* has yet to be devised. Yet many workers who are exposed to eye hazards will not wear goggles whenever they can avoid doing so. Such perversity, which is exemplified in the case of other devices (respira-

tors, gloves, etc.), indicates that, as a general principle, the safeguard should not be on the man but on the machine whenever possible, if the same measure of protection can thus be given.

Educational and propaganda safety work attempt to persuade the worker to use safety devices, and also instruct him to use foresight and caution in his work. It is claimed that two-thirds of the success attending accident-prevention schemes are attributable to such safety-first work. Posters and slogans, together with exhibits, can be used in the endeavour to adapt workers in the *mass* to industrial environment. General instructions are of little use; ~~and~~ interest must be maintained by variety and novelty in posters, and by appropriateness in slogans. Advertising ability, technical knowledge, the principles of education, and not a little psychology are indispensable in conducting safety campaigns. Valuable suggestions can often be obtained from the men actually on the job, and suitable posters, etc., are readily obtainable from safety-first associations.

In the spirit of further enquiry, and far from belittling the excellent work that they have accomplished, it is here suggested that such propaganda, like advertising or national education, appealing as they do to the *masses*, will always leave some people unaffected by its message. These either fail to grasp the import

of the principles which it is desired to impart, or else they fail to apply them in practice.

Individual Susceptibility to Accident

An investigation of accidents to munition workers indicated that individual susceptibility might be an important factor in accident causation.[13] An extensive statistical survey, carried out on behalf of the Industrial Fatigue Research Board, has since confirmed this view, and has shown that accidents are generally confined to a comparatively small number of workers in the group under consideration.[14] The existence of such *accident proneness* raises a doubt as to the desirability of preaching safety to those workers who are not so susceptible. It is quite possible that their confidence may be shaken and that an unnecessary apprehension may be suggestively induced by unduly emphasizing risks. Such might conceivably be the effect on a new-comer entering the industry.

The hope of the future appears to lie in the possibility of diagnosing proneness to accident and excluding susceptible individuals from those industries in which they would be a menace to themselves and to their fellow-workers. Careful research has shown that there is some relationship between accidents, on the one hand, and nervous instability and poor motor co-ordination, on the other.[15] Workers' organizations might with advantage sponsor further

investigation along these lines. The same report states that there is some indication that those prone to accidents are industrially inefficient; and this finding receives some confirmation from an experiment on the systematic training of a group of 140 learners whose average age was 15½.* Those who were dismissed because of their inability to acquire the necessary dexterity during training, sustained on an average more than twice as many accidents as those who became proficient. (Allowance was, of course, made for different lengths of service.) These findings suggest that a scientific selection of workers would probably tend to diminish the frequency rate of accidents; for there would be less strain on the individual, and less liability to fail when faced with a critical situation.

Such an important qualification as good vision receives relatively little attention in engaging workers, and the prevalence of poor vision is astounding. On testing the vision of 3,500 applicants for work of a fine nature, less than one-third were found to have "normal" vision in both eyes. Of 71 workers who had sustained the greatest number of accidents in a particular plant, 23 had vision less than half-normal in one or both eyes, and there were 23 cases of defective convergence or co-ordination.

* Stephenson, A., "Accidents in Industry," *J. Nat. Inst. Industr. Psychol.*, Vol. iii, No. 4, pp. 195-6.

The Need for Training

Next to the considered selection of suitable workers, systematic individual training should be stressed. The novice frequently becomes a general factotum who "picks up" the job as best he can. Is it then any wonder that inefficiency accompanied by preventable accidents should result? It is obviously important that special definite instruction should be given to young and inexperienced workers in potentially dangerous occupations. The mining industry has given a lead in this direction, and it is to be hoped that its wisdom will be apparent, and that other industries will not be slow to follow. In the third Annual Report of the Secretary for Mines (1923) it is stated:

"To lessen the risks of boys entering the pits an attempt is being made to arrange that they shall be educated in mining dangers in their last year at school, and at evening classes after they have left school. In this the industry has the help and support of the County Mining Education Organizers, who are in touch with the Mines Department."

A personal factor which is frequently stressed in investigating causes of accidents is *experience*. Accident frequency does diminish with increasing experience, but it should be remembered that youth and inexperience coincide to a large extent, so that age may play a greater part than experience. The majority of entrants into industry

are young people and there are certain qualities of youth (bravado, failure to realize danger, etc.), which tend to disappear with increasing age.

Why Accidents Occur

When a worker, who has already safely carried out the same industrial operation thousands of times, happens to meet with an accident, it is easy and convenient to attribute the occurrence to his carelessness or inattention. Such explanations are a confession of ignorance, and the investigation of the factors which they conceal is an important task for Industrial Psychology. Several possible factors, some personal, some environmental, may be cited, all of which have been traced in particular cases, although it is probable that some may be contributory to others, and that there may be yet other contributory causes to account for the momentary inadaptability of the worker.

Nervous instability has already been mentioned, and it belongs to the class of causes which may be called "temperamental." Female workers, for example, are often afraid of machinery on their first acquaintance. Because of urgent necessity, they may overcome their natural fear, but at what cost? They seem to become adapted, but the strain of suppressing an instinctive antipathy is bound to tell; and sooner or later, when for some reason they are

below par, vigilance breaks down and an accident ensues.

Apart from considerations of inebriety, there are weak moments in most people when they act directly against their better knowledge. It may be for the sake of an immediate gain, as when a piece-worker takes some unnecessary risk, some short cut, in the interests of the moment. The relative values which reason and experience have taught are replaced by values determined emotionally. With some temperaments this is more liable to happen than with others, and such people should obviously be saved from themselves, by being excluded from occupations in which there is a high degree of accident liability.

Consideration of the stages by which skill in repetition work is acquired assists in the understanding of the way in which "inattention" may be explained. "The first deliberate conscious efforts are replaced by semi-automatic movements which are thus subject to competition from other instinctively and emotionally more favoured impulses." In some workers these are so insistent that motor co-ordination fails and an accident ensues. The question then arises, why are such impulses more insistent in some workers than in others, and further, why some occasions seem to be more particularly favourable than others.

Although much further research is necessary,

there is already evidence to show that social and domestic conditions add their influence. Two cases may serve to illustrate this. One young worker who had sustained seven accidents in twelve months proved to be subjected to ill-treatment at home. Another, who had sustained four accidents in five weeks, threatened suicide when dismissed for incompetence. In investigating causes of accidents, it thus appears that home circumstances, previous training, and environment should not be overlooked, and that the responsibility for accidents should not be wholly attributed to industrial conditions.

Industrial environment (which includes illumination, ventilation, and humidity) and posture and fatigue doubtless also contribute to the total liability to accident. But in these fields there is much yet to be learned. The inferior illumination of artificial light compared with daylight is accompanied by an increase in accident frequency. Some records have shown that more than twice as many accidents occur in the two winter quarters of the year for the part of the day when artificial illumination was used, as for the corresponding part of the day in the two summer quarters of the same year; while excesses of 86 and 25 per cent. of accidents have been recorded as due to artificial illumination.

Accident frequency seems to be related to inadequate ventilation as measured by the

kata-thermometer.* An investigation carried out in coal-mines has shown that high frequency and severity rates for accidents are associated with low cooling power of the air.[16]

The contributory effect of temperature towards liability to accident is shown by the following diagram. Accidents were at a

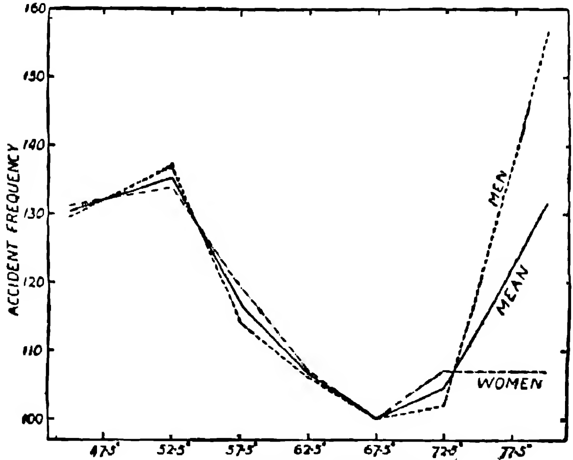

Fig. VII.—(Osborne and Vernon).

minimum at 67·5° F. When the temperature fell to 52° F., accidents increased by 35 per cent. At temperatures of above 72° F., they increased very rapidly in men, but only to a small extent

* See Chapter III.

in women. This difference may have been due to the heavier work performed by the men.

The influence of fatigue on accident incidence is complicated by that of the rate of work. Some have maintained that varying speed of production, not fatigue, is largely responsible for day-shift variations of accidents. As the result of an investigation of 50,000 accidents, Vernon, for example, states in his *Industrial Fatigue and Efficiency* that he considers it probable that a small increase in output may lead to a large increase in accidents. And he cites cases where accident frequency during afternoon shifts, when fatigue might be expected to be more in evidence, is not appreciably different from morning frequency. Nevertheless, fatigue *may* be an important contributory cause, for accidents sustained by women have proved to be two-and-a-half times as numerous during a twelve-hour day as during a ten-hour day.

On night-shift work, however, it is found that accident frequency decreases instead of rising at the end of the shift. This striking difference from day-shift observations has been attributed to the operation of a physical factor. The day workers arrive calm and grow more careless and excitable as the midday break approaches; while the night workers, having already been up some hours, arrive excited and calm down towards the morning.

It is clear that uncomfortable posture at work will more readily induce fatigue, and so provide another possible contributory cause.

Extreme caution must be used in interpreting the findings so far available, and the guiding principle that the cause of an accident is seldom simple should always be borne in mind.

CHAPTER VIII

THE MEASUREMENT OF INTELLIGENCE AND APTITUDES

By F. M. Earle

The problem of estimating the innate ability of a boy or girl, man or woman, is as old as the race; for with the division of labour came specialization, and it could then be observed that the most perfect products of such specialized activities were only to be produced when the best training was added to the highest innate ability. The methods of determining those persons who are fittest to receive a particular kind of training have varied from generation to generation and from one country to another. But the basic problem has remained the same, even though its successful solution has tended to become more and more difficult as new occupations and industries have arisen.

At one time the admission of recruits to any highly organized craft or occupation was controlled by a system of apprenticeship and probationary service; from observations made during this preparatory period the master-

craftsman or the merchant would decide whether or not to offer the apprentice permanent employment. No doubt into his training the employer would introduce tasks designed to bring out the apprentice's intelligence, adaptability, resource, initiative, and special skill, and he would frame his judgments accordingly. Under such circumstances we can easily understand how the quality of workmanship came to be very high.

In modern times, however, the changes in the nature and organization of our principal industries and occupations, and the extensive use of power-driven machinery, have resulted in the almost universal abandonment of this system. It has been unusual for the employer to expend much care upon the selection of his employees. A crude "hire and fire" system, with its consequent large labour turnover and reduced efficiency, has been customary except in the case of appointments to the most responsible positions. Even in these, the question of ability has often been held to be subordinate to other considerations such as personal appearance, social class and the like.

On the other hand, candidates for positions in the Government service, and in all occupations in which special *knowledge* or *skill* is required, have nowadays to submit to an examination designed to measure the range of their attainments. Thus a shorthand-typist will be examined in the speed and accuracy of her work,

a teacher in his knowledge of the subjects he proposes to teach, a doctor in the diagnosis and treatment of diseases and so forth. It is usually assumed that the possession of a certificate indicating the nature of the knowledge or skill reached by an applicant is a guarantee that the requisite ability is also possessed. When a personal interview of each candidate is considered necessary, it is almost invariably directed towards the estimation of those personal qualities which can only be disclosed in such a way, ability being taken for granted.

But knowledge and innate ability are not identical; and from the point of view of future achievements a person of high innate ability is, in the end, more likely to prove successful than one who through experience and training has gained more knowledge but possesses less innate ability. In some instances, it is true, knowledge is itself an indication of ability. The possession of a university degree in Arts or in Science, for example, may be taken as a measure of ability, since those who lack the minimum intellectual capacity necessary for the successful mastery of such subjects are eliminated at earlier stages. Even so the variable standards obtaining in the case of pass degree candidates often compel those who look for the most able persons to stipulate for a degree "with honours." There are obvious dangers in using certificates as a test of ability, although, as we shall see, it is im-

possible to avoid measuring ability by means of the knowledge or skill which has been acquired. But it is essential to standardize the conditions of examination in such a way that the meaning of the result may be interpreted with reasonable accuracy and reliability. Not all knowledge can be used safely to indicate differences of ability. Some kinds are more easily acquired and more easily retained than others; and, provided that all the competitors possess the minimum ability needed, the difference in knowledge exhibited by them may only indicate differences in assiduity, in skilful direction of studies, in time spent, and the like. If so, it will be well to know of them. It may be argued that the purpose of an examination is chiefly to guarantee the *minimum* requirements in knowledge and in ability necessary for the work, but the fact remains that the majority of examinations are competitive and the rewards usually go to the highest in the lists. Besides, there are numerous occupations in which the value of knowledge *per se* is small, the ability required depending more upon manipulative skill, or upon physical strength and endurance, or even upon sociability and a pleasant manner. When admission to such occupations is determined by an examination in elementary-school subjects such as English and Arithmetic—instances of this might be quoted—the examination system is seen at its worst.

It is most important, however, to bear in mind the difference between the engagement of skilled workers (including members of the professions) who must necessarily possess certain degrees of knowledge and skill, and the engagement of learners. The latter are to be trained over a long or short period; although they possess none of the knowledge or skill which is the ultimate aim, they must be capable of benefiting from the training they are to receive. Can their ability to learn be in any way satisfactorily determined so that the time of training shall not be wasted? Does schooling develop a young person's innate abilities sufficiently to enable a satisfactory estimate of vocational aptitude to be made?

The second question has been frequently answered both by the successes and by the failures of the teachers' "prize pupils." Generally the estimate of the school is not wholly satisfactory, and some other basis of measurement seems desirable. But the problem is a complex one because the needs of our social and industrial life are so numerous and varied. We have to determine, as far as we can, which of the principal factors in success—ability, knowledge, character, skill or physique—are relatively most important in each occupation, and then to devise some reliable means of measuring each of them apart from the influence of the others.

At this point it is advisable to remark that

human beings certainly vary greatly in their innate capacity to acquire knowledge and skill, as well as in their physique, temperament and character. At one time such a statement would have been unacceptable to a great many people; philanthropists, educationists and philosophers worked and taught in the belief that all men are equally endowed in respect of potential ability and only differ in opportunities for development. But within recent years, especially through the influence and example of Francis Galton, the difficult question of the relative effects of heredity and environment has been approached in new ways and by new methods, and the results of the experimental work of nearly half a century are all in support of a belief in the inborn nature, not only of genius, but of all the differences in ability which express themselves so characteristically in human life.

The new methods are of two kinds. In the first place, methods of examination have been developed by which it is possible to gain a measure of our innate abilities independent of the acquired knowledge in which they are usually expressed. This is the principle underlying practically all the so-called "psychological tests" which have been invented since Alfred Binet published his first graduated scale of mental tests in 1908. The second method is based upon the statistical examination of the

data obtained from the use of such tests. New applications of statistical principles have been devised and their use greatly facilitates the study of individual differences. It is not too much to say that a new science is being developed out of the study of the correlations of human abilities, the applications of which are likely to be of far-reaching importance.

Psychological Tests

(*a*) *Intelligence Tests*

The development of the use of psychological tests has proceeded, in the main, along two distinct lines. The attempt to measure the mental function (or functions) popularly called "intelligence" came first; and consequently, at the present time methods are technically more advanced in the measurement of intelligence than they are in the measurement of any other ability. After the publication of Binet's scale of tests development was rapid. The value of such measures in solving problems of school organization, in sorting out children according to their mental powers instead of according to their age, and in determining with confidence those who lack sufficient educable capacity to enable them to profit from the ordinary school curriculum, was at once apparent. A small army of "mental testers," amateur and professional, was soon at work and new tests began

to appear in rapid succession. The colossal feat of applying such tests to one-and-a-half million men in the course of the first World War when allotting recruits to different branches of the American Army gave the whole movement the stability which otherwise it might have attained only with difficulty. Consequently during the last twenty-five years development has proceeded along certain well-defined lines. It has become more and more clearly recognized that the construction and use of such tests constitute a science in themselves; and in the present War the many tests used by the British Fighting Services are constructed solely by competent psychologists.

(*b*) *Tests of Vocational Aptitude*

So spectacular was the early progress in the use of intelligence tests that the possibility of extending their use to the solution of industrial and occupational problems soon began to be considered. But the first attempts to use "intelligence" tests as a means of discovering vocational aptitudes were disappointing. One enquirer after another found that there was little or no agreement between success in such tests and success in occupations ranging from salesmanship and engineering on the one hand to various workshop and factory "jobs" on the other. Consequently greater attention began to be paid to the special requirements of each particular occupation; and tests began to be

devised for the purpose of selecting those who possessed the requisite abilities. Such tests were naturally called "vocational tests," and, for a time, they were intended principally for use in the selection of applicants for employment.

Curiously enough, a similar result had been reached several years before by the application of laboratory methods to the same problems. Tests based upon a psychological analysis of the duties involved had been devised by Münsterberg for the selection of tram-drivers, and his methods were extensively copied. Procedure has naturally varied somewhat between one country and another; but the aim has always been to secure a scale of tests which shall adequately measure the more important abilities essential to success in the occupation under consideration. In Great Britain, a good deal of the important work of this kind has been done by the investigators of the National Institute of Industrial Psychology * and of the Industrial Fatigue (now Health) Research Board.

Concurrently, interest in the measurement of special abilities also arose out of the needs of the work of vocational guidance. Organized attempts to place young people in suitable employment through the co-operation of teachers, employment officers, welfare workers and employers, have been in existence in this country

* A detailed description of the principles and method will be found in Chapter X.

from forty to forty-five years. Out of them has developed a realization of the need for a scientific exploration of a child's aptitudes, attainments and general character, as a means towards the better selection of a suitable career. Hitherto, such action has perhaps been more marked in the United States of America and in certain large towns in Europe than in this country. But within recent years more attention has been paid to problems of this kind, and the National Institute of Industrial Psychology has taken an active part in developing and using psychological tests for this purpose.

Mental Measurement as a Science

So much for the origins of this new science. How far is it justified in claiming to be a science and upon what principles is it founded ?

Mental measurement may claim to be scientific when its methods are systematic and when the principles upon which these are based are consistent with themselves and with the results of other methodical enquiries. No collection of principles in any science can claim ultimate truth. But so long as the working hypotheses upon which the methods of the science are founded continue to explain most (if not all) of the observed facts, the applications of the science in different directions are likely to be helpful. The chief difficulty which the psychologist has to overcome is that the data to which he wishes

to apply his laws are not, as a rule, capable of complete control. It is rarely possible to obtain that degree of precision in measurement which is typical of an experimental investigation in physics. Subject to this limitation, however, the data obtained from a properly conducted psychological experiment may claim a validity as high as that obtainable in many other sciences. Some of the principal working hypotheses in the construction of mental tests are as follows :

(*a*) Persons differ in their innate abilities as well as in their acquired knowledge and skill ; the differences in the latter may be due to a variety of causes, the influence of innate ability being usually the greatest.

(*b*) The abilities needed for different tasks are not identical.

(*c*) The innate abilities of any single person for a number of different tasks are not necessarily equal. Consequently most people succeed better in some tasks than in others.

(*d*) Other things being equal, persons of high innate ability for a particular task will achieve greater success in it than those possessing less innate ability for the same task.

(*e*) Success so attained may be measured in various ways :

(i) By the difficulty of the task. Other things being equal, a person who performs very difficult tasks is more able than one who can only succeed in easy ones.

(ii) By the number of the tasks successfully performed. If all the tasks are of equal difficulty, the most able person is the one who can do the largest number of them.

(iii) By the rate at which the tasks are successfully performed. Other things being equal, the quick worker is more capable than the slow worker.

The aim in psychological tests, as in all scientific experimentation, is to ascertain and to maintain the conditions under which the innate differences above mentioned will adequately show themselves. Stated thus, no difficulty generally arises. It is only when we come to consider the nature of the abilities needed for different tasks that we encounter serious differences of opinion. Considerable discussion has taken place as to the essential nature of human abilities; and the problem is by no means settled. It will not be possible here to discuss the subject fully, but we may briefly examine the alternative views. The problem is of considerable importance because in the end our methods of examination, to be successful, must be adapted to the nature and mode of expression of the abilities to be measured.

There has been a tendency of late years to avoid unprofitable discussion by concentrating upon the improvement of intelligence tests and other tests in general use without bothering much as to the essential nature of the ability that is

being measured. But it is clear that, in the end, progress will only be made when finer distinctions can be drawn between one ability and another and when correspondingly finer methods can be used for their isolation and measurement. The question is whether we need to wait until this highly refined science has been perfected before attempting to differentiate quantitatively between the abilities of human beings. The answer is that in all other sciences application of existing knowledge has always taken place even at the crudest and most elementary levels, and that, for the most part, advance has come more rapidly through such applications than in any other way. Hence we are justified in applying these new methods to the solution of our problems, even although they may be comparatively imperfect and their theoretical bases may still be in doubt. It will be the surest and quickest way to improvement.

Theories of Ability

In an endeavour to explain the observable differences in the ability of individuals to perform different tasks, several theories have been put forward during the twentieth century which, though seemingly opposed, are not beyond reconciliation.

Thorndike,[17] having observed that there was apparently no degree of correspondence between

the success of a person in one task and his success in a number of others, and also that the experiments of other research workers constantly yielded similar results, concluded that the abilities of man consist of numerous single unrelated elements. But the experiments which were the original basis of this conclusion were of a heterogeneous nature and included the measurement of many sensory and motor as well as mental processes.

Since that time, however, there has been a vast accumulation of results obtained from the use of mental tests. These tests, as Binet devised them, did, in fact, represent an attempt to measure a number of separate abilities, simple and complex, which, in children, were expected to have reached definite stages of development at certain ages, these being ascertained by studying the answers given by large numbers of children at each age under consideration. Standardized in this way, the tests enabled the examiner rapidly to compare the ability of one child with that of other children of the same age, sex and race; but the scale was admittedly an imperfect composite, making use of a variety of apparently independent mental and physical processes, and being in some respects far from complete. Those who have since sought to improve and extend the Binet scale of tests seem to have applied a somewhat different view to the interpretation of the same data. They have

come to believe that there is a general mental power (intelligence) which is the principal factor in success in the Binet tests, and that its growth is being shown in the capacity of the child, increasing from year to year, to succeed in tasks of correspondingly suitable difficulty. It is not surprising therefore to find that the practical work of intelligence measurement has led to a considerable modification of Thorndike's earlier theory as to the complete independence of mental abilities.

Spearman,[18] on the other hand, approaching the problem from a different angle, has consistently sought for a more systematic explanation of the available facts. Starting from the belief that the contradictory results which had been obtained by Thorndike and earlier workers as to the co-relation between various abilities were due to uncorrected observational errors, he devised a method of eliminating the purely accidental errors of measurement, with the aid of which he demonstrated that there was a significant degree of relationship between abilities which had hitherto been considered to be unconnected. This led to his important "two-factor" theory in which all human *mental* activities are considered to depend for their successful operation upon at least two factors—one a "general" factor common to them all, the other a "specific" factor peculiar to each activity. The general factor, called "g,"

operates to greater or less extent in every mental activity, whereas the specific factors vary from one task to another.

These specific factors are regarded as almost entirely uncorrelated ; that is, there is no factor common to them all, while the occurrence of one or more factors common to groups of them is only to be expected infrequently and over a very narrow range. If there were definite bonds of connection between groups of abilities other than that due to the general factor "g," we should be able to use our knowledge of a person's proficiency in one activity to predict his probable success in any other activity belonging to the same group.

The existence of such "group" factors—which, over a wide range, would be practically equivalent to the old doctrine of "faculties"—was, however, originally doubted by Spearman, who considered that the combination of a single general ability ("g") and a number of unrelated specific factors ("s") was sufficient to explain all the major differences in mental abilities which he had experimentally investigated. If "overlaps" of specific factors occurred as between the ability to perform one task and that required for success in another, it was usually because the tasks very closely resembled one another, so that the combination of "g" and "s" was very much the same for both. Spearman, however, always recognized the possibility of group factors, and

in his more recent work he has come to lay increasing emphasis on their importance.

The question as to whether "group" factors, as above described, do or do not exist has led to some interesting controversial discussion. Most of it has arisen, however, because Spearman's conclusions are based upon a mathematical analysis of the data obtained from the use of mental tests, and different interpretations have been put upon the results of such analyses. Thomson,[19] for instance, has suggested that Spearman's mathematical criterion for the existence of a general factor "g" is equally consistent with the presence of a number of group factors instead of one single general factor. By artificial arrangements of data, in which group factors are known to be present without any general factor linking them together, he has shown that Spearman's criterion can be otherwise satisfied. Consequently, since he regards the two-factor theory as "unproven," Thomson prefers to look upon complex human abilities as combinations of large numbers of elementary abilities which, since they may be variously combined, are generally co-related by means of common (or "group") factors. Such combinations, he thinks, vary from one person to another and represent a "sample" of all the abilities which each has at his command.

But the final solution of these differences lies in the future. It is impossible here to deal fully

with these and other interesting views which have been put forward; such, for example, as Hazlitt's [20] interpretation of special abilities as being organized systems of acquired knowledge and skill, originating in a general ability (cf. Spearman's "g") which enters into all mental activities. From a practical standpoint it may be said that Spearman's contributions to the question are, and have been, of the greatest value. The concept of a general basic ability (no matter what name we give to it) has been an extremely useful one. Still more helpful, however, has been the belief in the innate character of this basic ability in the individual, a belief which gains much support from experimental enquiries showing that the measure of the "intelligence" of a child remains approximately the same, age for age, throughout his school life. Even though such measures are, according to Spearman, only partial measures of "g," they support his general principles.

The position at the present time may be summarized by saying that the science of mental measurement is being slowly but surely established. Methods have been evolved which are proving successful in practical application; and although there are still differences in interpretation, these do not seriously affect the general usefulness of the methods. Improvement in the future will come both through further refinement

of method and the more direct association of theory and practice.

Practical Application at the Present Day

It will make the previous discussion clearer if a brief account be given of the practical methods now in use for determining the abilities of any individual. A good illustration is to be found in one of the experimental enquiries carried out by the National Institute of Industrial Psychology. Those qualities which it was thought desirable to investigate were classified as follows.[21]

A. Intellectual Capacity.

1. General Intelligence.
2. Specific Capacities such as manual dexterity, mechanical ability, etc.
3. Educational Attainments.
4. Special Interests.

B. Temperament and Character.

1. Emotional Qualities (cheerfulness, assertiveness, timidity, etc.).
2. Moral Qualities (honesty, industry, etc.).
3. Social Qualities (ability to co-operate with others).

Of these only those falling under the head of intellectual capacity can at present be measured directly and call for description here. At the same time, considerable progress has been made in the direction of obtaining more accurately a

quantitative estimate of a person's temperament and character, for without some study of these aspects vocational guidance would be much less valuable than it now is.

The methods of measurement adopted have been as follows :

(1) *General Intelligence :* Two main types of test have been widely employed for the measurement of intellectual capacity—individual tests and group tests. To the former class belong the modified Binet scales of tests, consisting of questions such as " What day is it ? " " What is the difference between paper and cloth ? " and the like, carefully graded according to the age of the child.

All the questions are given orally and most of them require a verbal answer. For this reason problems of a more practical kind, requiring the doing of some action, simple or complex, as may be necessary, have been devised ; these have been distinguished by the name of " performance tests." [22, 23, 24] They have been found useful additional means of measuring the general ability of the examinee, especially in those instances in which he may not have done himself justice in the oral examination.

One of the simpler " performance tests " is illustrated below. The materials are two wooden blocks and 18 small cubes. Each block is composed of nine small cubes ; the first is painted red on the sides but not on the upper or lower

surfaces, the second on the sides and on the top surface as well. The small cubes are painted on some of their surfaces and unpainted on others, so that when properly put together they exactly duplicate the painted surfaces of the blocks. The blocks, with their appropriate cubes, are presented separately and the candidate is told to put the cubes together so as to make a large block exactly like the model. The score depends

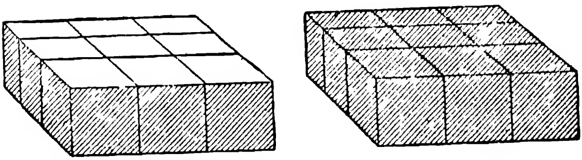

FIG. VIII.—(F. Gaw).

on the time taken and the number of " moves " made.

The group tests are differently constructed and used. They are mostly " paper and pencil " tests for examining simultaneously large numbers, thereby saving a great deal of time. They are based on the principles enunciated earlier in this chapter. Consequently if the tests are suitably graded in difficulty and contain a sufficient number of separate questions, they will give a sufficiently reliable measure of a person's ability for most practical purposes. The type of question most frequently used resembles one or other of the following :—

(*a*) *Opposites and Synonyms.*

Example. — *Tender, Tough* are words of (opposite, same) meaning.

Underline the correct answer.

(*b*) *Analogies.*

Example.—*Good* is to *Bad* as *White* is to (clean, black, wicked, best).

Usually four words are given, the appropriate one to be underlined.

(*c*) *Sentence Completion.*

fell
Example.—The man rode off his bicycle and
climbed

cured
broke his arm.
changed

Complete the sentence sensibly by underlining one of the optional words.

(*d*) *Mixed Sentences.*

Example.—night sleep time is at the to best.

Rearrange the sentence and say whether it is true or false.

(*e*) *Reasoning.*

Example.—C is west of B; B is west of A. Therefore A is (North, South, East, West) of C.

It may be mentioned here that Spearman finds a high correlation between the results of these

tests and his general factor "g." Consequently we may conclude with reasonable justification that there is some underlying general intellectual ability measured by tests of this kind.

(2) *Special Aptitudes:* To measure special abilities, apparatus of some kind is generally needed. The object of the test is to impose such conditions that the candidate's behaviour and success may fairly be taken as an indication of his ability to work successfully at a task in which similar conditions operate. For this reason tests of special abilities often bear a close relation to the kind of task or situation which is usual in the occupation to be considered.

Thus in testing for ability to deal with problems of a mechanical kind, introducing perhaps the application of elementary principles of mechanics, a collection of common objects such as a lock or a bicycle hub may be used. These objects are taken to pieces and the candidate is given the parts and any necessary tools, and he is required to construct the object within a certain time. His success is determined by the accuracy of the work and the methods he employs, as well as by the time taken.

Similarly, tests for engineering ability include several tasks comparable to such workshop processes as drilling and lathe-operating, while tests are also included which require an analysis of a practical situation and a grasp of the problems involved. In so far as such tests are devised

in relation to the elements of the complex system of abilities which enter into the " make-up " of a successful practical engineer, they follow the general principles adopted in vocational selection, already referred to.*

Tests of manual dexterity, again, introduce comparatively simple tasks such as threading beads, placing pegs in holes in a board, tapping a key, screwing a nut on a bolt, and the like, all of which require either a speedy or a dexterous manipulation of the arm, hand and fingers, but often a combination of both.[25] The most skilful person is usually the one who can carry out a movement of high precision and delicacy of adjustment at high speed. It is not difficult to test a person's ability for movements of this kind, but it is difficult to separate the influence of training and practice. Of recent years the two-factor theory, already described in this chapter, has, through the development of various mathematical and statistical methods of factor analysis, largely given way to a multi-factor theory of mental abilities.

Moreover, it has become generally recognized that the factors isolated by factor analysis are merely convenient tools or descriptive concepts, not necessarily having a physiological or biological basis. They have much the same convenience, with much the same "reality," as the lines of latitude and longitude (the equator,

* Described more fully in Chapter X.

for example) drawn by the cartographer upon a terrestrial map.

Doubt has arisen as to the existence and relations of certain abilities, e.g. of practical ability ("F") and of mechanical ability ("M"). Doubt has also been expressed whether performance tests of intelligence can differentiate practical ability, as verbal ability ("v") is commonly recognized to be separable, from general intelligence ("g"). By some, practical ability has been identified with spatial judgment ("k"). As measured by mechanical models, mechanical ability seems to depend almost wholly on two factors—general intelligence and spatial judgment. And the same two factors in different degrees are involved in the various space perception (or form relations) tests in which success depends essentially on the identification of a shape seen in one position with the same shape seen in another. By many, spatial judgment and mechanical ability have been thought the same.

There is increasing evidence that certain mental factors, e.g. spatial judgment, depend on adolescence for their maturation. We may have reason therefore to adopt the view that tests cannot safely select children for technical school education before the age of twelve or thirteen.

CHAPTER IX

CHOOSING A CAREER

By Angus Macrae

The Importance of the Choice

"Our day of work," so writes Rabindranath Tagore, "is not our day of joy—for that we require a holiday; for, miserable that we are, we cannot find our holiday in our work." And there have been moralists who regarded work not merely as a thing which should be enjoyed but as the sole and sufficient means whereby all our latent powers may realize themselves, and the whole nature of a man come to its full fruition. If that be sound doctrine—and few would deny that it has a basis of truth—how supremely desirable that each man's occupation should be suited to his natural capacities! For let a man choose his work unwisely and he remains a mere potentiality, a stunted growth, like a plant that cannot reach its true development in an uncongenial soil.

A directly opposite philosophy was that of the mythical crofter-fisherman of the Hebrides, who prayed that the peats might cut themselves

and the fish leap to the shore, leaving him free to seek the fullness of life in inertia and tobacco. But even if we regard work as essentially an evil thing, the need remains that we should choose our occupation with care. For, at the very least, it is certain that an occupation which is adapted to our abilities will prove less evil than one which is not so adapted. And may we not go further and say that if our work is suitable we shall surely discover in it some positive good, some real satisfaction? May not our Hebridean have had a mind altogether above herring and peat?

The principle of fitting the work to the man is indeed one which immediately commends itself to common sense and does not stand in need of reasoned justification. Nevertheless, it is not generally recognized how important is this question of occupational fitness and how serious and far-reaching may be the consequences of ' misfit." Let us therefore consider briefly this aspect of the matter.

The effect of vocational maladjustment on the mental condition of the worker depends partly on the nature of the maladjustment and partly on the worker's sensitiveness and his proneness to kick against the pricks. Sometimes there is only a vague and patiently borne dislike of the daily task, sometimes a profound dissatisfaction and unrest. The man, for example, whose work calls for more skill than he

happens to possess, may acquire a painful and paralysing sense of general incompetence and a haunting dread of complete economic failure. Another, although capable enough, is so ill-adapted temperamentally to his job that he shrinks from the day's work as from an ever-recurring ordeal. A third, with a capacity far above that demanded by his occupation or with a specialized gift for which it affords no exercise, endures all the irritations of thwarted ambition and utter boredom. Each is the victim of a mental conflict which may be wholly or partially "repressed" into the unconscious part of the mind, where it is only too likely to give rise to neurotic disorder of a more or less grave kind. Actual insanity has been known to result, and attention has been recently drawn to the need for wise vocational guidance as one instrument for the prevention of mental disease.

It is unnecessary to emphasize the danger of work which imposes too severe a strain on the physical resources of the worker, and it need scarcely be said that the mental disturbance caused by any form of occupational maladjustment cannot fail to react unfavourably on the general bodily condition. But in certain special cases curious local symptoms are produced which may have a seriously disabling effect. Telegraphists' cramp is an example in point: this condition is still imperfectly understood,

but careful research carried out for the Industrial Fatigue Research Board has shown that psychological factors are involved in its causation and that those operators who are temperamentally unequal to the exacting demands of the work are especially liable to suffer.[26]

Again, uncongenial employment has been found to be a frequent case of delinquency in adolescents. Of a group of employable young offenders studied by Cyril Burt 10 per cent. were dissatisfied with their work, and the same author writes that among older children brought to him primarily for vocational guidance, and not on account of misconduct, those who were misplaced in their occupations often proved, on fuller enquiry, to have been led, as a direct result, into unsuspected offences.

It is not, of course, suggested that all individuals who are unsuited to their work are in imminent danger of becoming "nervous wrecks" or drunkards or criminals or lunatics; these are the extreme cases, though doubtless they are much more numerous than is commonly supposed. The important point is that for every one who suffers any such catastrophe there are multitudes who experience *some* degree of mental stress, entailing *some* wastage of energy, *some* impairment of physical well-being, *some* diminution of happiness.

But the evil is not confined to the worker himself nor to his hours of work. It will tend

to dog him during his leisure and to affect all with whom he has contact. The possible domestic consequences of the occasional "bad day at the office" are common knowledge; but what may be the lot of many a family whose presiding genius spends six bad days at the factory per week?

Finally, the employer of the vocationally unfit may be by no means the least deserving of sympathy in the case. He loses time and money through the spoiled work and low output of those who are unequal to or uninterested in their jobs, and through his futile attempts to train those who subsequently have to be discharged as "unsuitable." But industry may suffer in other and less obvious ways. The inefficient and discontented worker will tend to be more frequently absent through sickness, real or feigned, than will the man who is happy at his job, and, if the work contains an element of danger, he will also be more liable to accidents. Further, the bad craftsman is just as likely to blame his master as to blame his tools, and may become a source of unrest and disaffection among his fellow-workers. It may well be that many a man becomes a professional agitator mainly because he has had the misfortune to be wedded to an uncongenial task.

Such are some of the evils of vocational unfitness. Having regard to these evils alone, and apart from considerations of any superlative

good which may accrue to a man from work which is well adapted to his nature, can we doubt that the choosing of a career is a vastly important matter, or that the realization of the ideal of "every man in his right vocation" would result in an immense reduction of human misery and economic waste?

The Usual Methods of Choice

"To each," wrote Carlyle, "is given a certain inward talent, a certain outward environment of fortune; to each, by wisest combination of these two, a certain maximum of capability. But the hardest problem were ever this first: to find by study of yourself, and of the ground you stand on, what your combined inward and outward capability specially is." And Samuel Johnson, writing to Boswell on the choice of a profession, expressed the opinion that "to prefer one future mode of life to another upon just reasons requires faculties which it has not pleased our Creator to give us." This pessimism is not shared by the London child who, at the immature age of fourteen, is about to leave the elementary school and join the ranks of industry. Ask him what particular walk of life he has chosen to follow and he will generally give you a ready and a confident answer. Let us see what grounds he has for this most critical of decisions, that he steps so boldly where sages fear to tread.

In the first place, it is clear that he is not altogether ignorant of his mental and physical capacities, and that he cannot fail to have a casual acquaintance with a certain limited number of occupations. And often, by relating what he knows of himself to what he knows of the jobs, he arrives reasonably enough at a decision regarding the general type of work in which he is most likely to succeed. But beyond this his knowledge is usually too slight to carry him with safety. Consider the boy whose school record is a very indifferent one, but who has proved himself capable when it is a matter of mending a broken lock or handling any sort of mechanical contrivance. He may wisely decide that his place is in one of the occupations which require this special kind of practical ability. But there are many "mechanical" trades, including—to mention only a few—those of the engineer fitter, the electrician, the plumber, the watchmaker and the printing-machine operative. How shall he prefer one of these "upon just reasons"? Usually, the final choice will be determined by chance, and the result may be satisfactory or disastrous.

But it frequently happens that logic enters little, if at all, into the matter, there being something in the child's emotional "make-up" to which the job makes an immediate appeal, so that he chooses it simply because he "feels sure he would like it." There was a boy, heavy

and immobile and inarticulate, who, having watched men making tombstones in a yard which he daily passed on his way to school, conceived a great ambition to become a "monumental mason." Granite had called to granite, and in truth the job appeared to be one at which that particular boy, like Kipling's painters at their heavenly canvas, could "work for an age at a sitting and never be tired at all." In such a case it almost seems as if the individual possessed an unconscious urge which infallibly directs him to his vocation; and in his book *Personality* Dr. R. G. Gordon contends that this is precisely what occurs in the case of the normal man. Whatever may be thought of this theory, it is certain that the child's own feelings often lead him to choose work which is well suited to his general emotional constitution, and that sometimes the work so chosen is also well suited to his abilities. And it is equally certain that this happy association of interest and aptitude is frequently absent, and, moreover, that in many cases the appeal of the work comes merely from one of its less important features, and is directed to only an insignificant part of the child's temperament.

One has met a girl whose protective impulse made her keenly desirous of becoming a hospital nurse, and whose intelligence was quite unequal to the demands of such work. One has met a boy with a strong nomadic tendency, an unusual

lack of sociability and tact, and an eager ambition to be a commercial traveller ; and another whose longing to fly could only be interpreted as an unconscious attempt to find in a dream-world the physical superiority denied in the world of reality. We must conclude, then, that the child who chooses the job which most strongly attracts him is on no surer ground than he who attempts to make the decision on the logical plane.

But what shall be said of the boy who decides to be a printer simply and solely because printing is a "good trade"; or a plasterer because his "sister's fellow has promised to speak for him"; or a cabinet-maker because then, if his mother's chairs were broken, he would be able to mend them for her? The last is admittedly an exceptional case, but the reasons given in defence of the choice are in many instances hardly more substantial, and often, as one listens to them, one finds it difficult to realize that these are decisions which will shortly issue in action, and not mere fantasies of the nursery.

Sometimes, however, the child is unable to make up his mind on the subject, and sometimes his parents or teachers force or persuade him to alter his plans. Parents vary greatly in their attitude to the problem. There is the intelligent and well-intentioned parent who is anxious that Tommy should "learn a good

trade," but who, having little exact knowledge of the child, tends to consider the goodness of the trade in general rather than its goodness for Tommy. There is the short-sighted parent who will not allow Tommy to become apprenticed to skilled work because a blind-alley job will, in the immediate future, be found more remunerative. There is the parent who, because he himself works in a slaughter-house, decides that Tommy must work there also, Tommy in this case being a particularly affectionate child who happens to have taken his temperament from his mother, and who spends most of his leisure in the company of his well-loved animal pets of which he owns four varieties.. There is the generous parent—and perhaps he is the wisest —who, whatever Tommy's wishes may be, is "not prepared to stand in the boy's light." And there is the puzzled parent who means to "have a word with the teacher about it."

The teacher has some knowledge of the child's abilities and much knowledge of his character, but as a vocational adviser he has serious limitations. In many cases scholastic success is no true measure of intelligence, and in no case is the child's performance in the carpentry class a sufficient indication of his practical capabilities. And even if the teacher had more knowledge of the child, his ignorance of the jobs would prevent his applying this knowledge effectively to the vocational problem.

One hope remains. Towards the end of his final term the child appears with his mother before the school After-Care Committee's conference, which is attended by a representative of the Juvenile Employment Exchange. This lady is in touch with the changing conditions of the labour market and possesses much information regarding openings and prospects and general environmental conditions in the locally available occupations. She may even know, in a rough general way, the degrees of intelligence required in different trades, or the standards of scholastic attainment demanded by different employers. But she has no detailed knowledge of the individual processes and she has no more information concerning the child than is supplied by the teacher. And, with great respect for her ability and sympathy and tact, it must be said that her suggestions are often shots in the twilight, if not in the dark. "What about leather casemaking?" she may say, when Tommy has declined to consider a number of other possibilities—"that's a fine trade for a smart boy like you. Don't you think it would be nice to make suit-cases and attaché-cases and that kind of thing?" And she smiles so patiently that Tommy would be a churl to repeat "No, Miss" any longer. So Tommy says, "Yes, Miss," and it may be that five years later we shall find him a happy and successful maker of leather cases. Yet, for any con-

siderable voice that reason had in the matter, he might as well have become a maker of steam-rollers or of wedding-rings.

The Psychologist's Method

We have seen something of the danger attending the choice of occupation, and we have noted the inadequacy of the grounds on which the choice is commonly based. What the psychologist's method of attacking the problem must be will already have become apparent. Interpreting Carlyle's words in the widest possible sense, he must attempt tc survey the child's whole " inward talent " and his whole " outward environment of fortune "; only when he has correlated the results of these two enquiries can he help him to decide " what his combined inward and outwàrd capability specially is."

The measurement of general and special abilities has been discussed in Chapter VIII ; a few words on the assessment of temperament are in place here. Tests of temperament have been the subject of much experiment, particularly in the U.S.A., but in Britain dependence is usually placed on the older methods of the interview. A varying amount of information is obtained from a brief study of the child's physical appearance, facial expression and general deportment. There are children who possess, in a phrase of Bernard Shaw, "visibly proclaimed

temperaments": there is the boy, for instance, who belongs, physically, to the *type rond digestif*, and whom, after a first glance at his cheerful visage and friendly approach, one immediately places in the temperamental category of the *bon camarade.*

But the possibilities of variation within the type are so numerous that general classifications will not serve the vocational psychologist's purpose. He must know how the *bon camarade* stands as regards ambition, assertiveness, carefulness, reliability, and many other qualities which are not necessarily associated with *camaraderie.* Some of these qualities show themselves in the child's spontaneous remarks, in his manner of attempting the various test problems, and in his reactions to difficulties, successes and failures; information as to others must be gleaned from the answers which he gives to carefully planned questions concerning his hobbies, interests, and general opinions and habits.

In order to ensure that no important aspect of the child's personality escapes his observation, the psychologist records his judgments on a specially prepared schedule which contains in tabular form the names of all the vocationally significant traits and tendencies. He also uses the technical device of the "rating scale," assigning to the child, for each of the qualities studied, a grade letter or number according to the degree in which the quality is judged to be

present. These methods enable him to arrive at a much more complete and precise valuation than can be obtained by means of the ordinary unsystematic interview.

The moral qualities, such as honesty and industry, are the most difficult to assess. "There's no art," says Duncan in *Macbeth*, referring to the perfidy of the thane of Cawdor—

> "There's no art
> To find the mind's construction in the face:
> He was a gentleman on whom I built
> An absolute trust."

Here, however, the teacher, in virtue of his opportunities of extended observation, can render invaluable assistance. In all cases of temperamental or moral abnormality, the psychologist tries to judge whether the defect has an hereditary origin or whether it is mainly acquired; and if it is acquired, he tries to discover just where and why the emotional or moral development has departed from the normal course. He then endeavours to direct the child to an occupational environment which will exercise a corrective influence, or at least to one in which his prospects of happiness and success will be as little as possible prejudiced by his deficiencies or eccentricities.

Having measured the child's abilities and examined his temperament and character, the psychologist obtains from the teacher particulars of his scholastic proficiency. The school medical

records are also consulted, though indeed the information which they contain is often too meagre and too vague to be of great assistance. Finally, the psychologist interviews the parents in order to gain some knowledge of the family's past history and present circumstances, and to ascertain, in certain cases, whether further education can be afforded. He also notes the parents' opinions of the child's character, their wishes in regard to his future, and their special opportunities, if any, of placing him in a suitable situation.

But the investigation of the child's characteristics, attainments and domestic circumstances is only one half of the vocational psychologist's task. He must also examine the occupations, and especially those which offer opportunities of employment in the particular locality in which he works. There is no space here in which to describe the technique of "occupation analysis," as this study is called, and the curious reader must be referred to a report on the subject published in 1931 by the National Institute of Industrial Psychology.[27] The exact and detailed estimation of the psychological and physiological factors necessary for success in each of the almost innumerable departments of industry is, as may be imagined, a colossal task; and it is one which has scarcely been begun.

In judging of any particular child's vocational

fitness, the psychologist is first guided by the results of the intelligence tests. When these have been examined, many occupations are at once dismissed from consideration, as being clearly above or below the child's general mental level, and the appropriate vocational field thus acquires a wide and vaguely defined boundary. Next, considerations of special mental and manipulative abilities and of temperamental tendencies result in a gradual narrowing of the ground until, when all the data have been taken into account, only a few occupations, more or less suitable, usually remain for serious discussion. In every case the child's own wishes are carefully considered, and the career which he finds the most attractive is always preferred to others of an approximately equal degree of suitability. In many cases no perfect solution of the problem is found. The ideal qualifications for almost any occupation are so many and various that they are rarely all present in one and the same individual. Often it is only possible to conclude that, on the whole, one job seems likely to prove less unsuitable than the others. Always the aim is to direct the child to work in which as many as possible of his talents will be utilized, and which does not demand, as an essential requirement, any particular talent which he does not happen to possess.

Experiments in Vocational Guidance

In many countries, notably in America, vocational clinics have been established and "school counsellors" appointed for the purpose of directing the child at the outset of his industrial career. In this country the Industrial Fatigue Research Board and the National Institute of Industrial Psychology began, in 1924, a preliminary investigation of the practical value of the methods briefly outlined above. One hundred children, drawn from three elementary schools in London, were examined and advised on the choice of work, and, two years later, the same children were interviewed and their industrial record noted in relation to the advice which had been given. This experiment, a report of which has been published,[28] showed that scientific vocational guidance is not impracticable and made clear the need for further research. In 1925 the National Institute of Industrial Psychology was enabled, by a generous grant from the Carnegie United Kingdom Trust, to embark on a second and much more extensive investigation. The scheme of examination was widened by the inclusion of new tests, and each child was subjected to a special medical exploration, directed to the detection of those physiological and pathological conditions which are the most important in relation to the choice of a career, the doctor recording in each case the

particular occupations or environmental conditions which it seemed desirable to avoid, such as work involving climbing, or prolonged standing, or nervous strain, or exposure to the weather, or the breathing of a dusty atmosphere. Six hundred children were studied and advised, and their occupational progress was followed for four years after leaving school, together with that of a "control" group of an equal number of children who did not receive the Institute's examination and advice. Despite a number of unforeseen difficulties, the results once again attested to the promising value of vocational guidance when conducted along psychological lines, as compared with the unsystematic guidance hitherto and customarily offered. A full account of this experiment has been published by F. M. Earle (and others) in *Methods of Choosing a Career*.[29]

Further progress is marked in a third series of experiments begun in 1927 by the Education Authority at Birmingham and only interrupted or hampered by the present War. Throughout they have been conducted in the closest cooperation with the National Institute of Industrial Psychology. They fall broadly into two groups, the one concerned with the vocational guidance of mainly elementary school children, on which two reports have been published by the Education Authority; the other concerned with the selection of skilled apprentices for the

engineering and allied trades, centring round one of the City's junior technical schools, on which three reports have been published. The results have been highly successful. Children who had been given vocational guidance along psychological lines and who followed the advice given were very definitely placed to greater advantage in industry than those who, after receiving such advice, did not follow it. They were also far better placed than the children in the "control" groups receiving only the advice given at choice-of-employment conferences in accordance with the practice hitherto adopted in the City schools. Equally striking have been the results of applying tests of mechanical aptitude as part of the admission examination to the junior technical schools, especially when qualities of temperament and character were also taken into consideration. Increasing confirmation of such methods of vocational guidance and selection is also being received from other experiments and in other directions.

CHAPTER X

SQUARE PEGS AND SQUARE HOLES

By Winifred Raphael

The Social and Economic Importance of Vocational Selection

"YES, you will do, you can start with us next Monday." These are fateful words, for on the care and thought expended before they are uttered depends, to a large extent, the efficiency of industry and the happiness of its workers. If the selection of the workers admitted to a firm is not carried out skilfully one of two results will occur. Either there will be a poor level of work, or there will be a high rate of labour turnover. A careful study of the relative ability of various workers will often show that there exists an almost astounding diversity. In the course of psychological investigations it is necessary to measure the difference in output of workers of equal experience, over a long period. Quite frequently it is found that men sitting side by side, identically equipped and with equal opportunities for work, will show a difference in output of 50 per cent., and it is no unusual thing to find

differences of as much as 100 per cent. In most cases these differences are found on investigation, not to be due to variations in willingness or keenness, but to actual differences in intellectual or manual ability.

As has already been said,* because a worker is not suited for one job it by no means follows that he is not suited for another. A poor clerk might make an excellent mechanic, and a good salesman would quite likely prove an inefficient farmer. It does not require much imagination on the part of any one of us to think of occupations in which we would probably have made a success and of others in which we would almost certainly have been a failure. If a worker is given a job for which he is naturally ill-suited, it is as much a detriment to his own chances of happiness and success as it is a handicap to the firm who engaged him.

Although a firm uses unsatisfactory methods of selection, it may still demand a good standard of workmanship. It will then follow that there is a high labour turnover, for all the incompetent workers engaged will have to be dismissed.

For practical purposes the most convenient method of expressing labour turnover is the ratio of workers leaving in any period to the average number employed in that period. If a firm employing a thousand workers loses 300 in a year (which is quite a usual proportion), the

* Chapter IX.

labour turnover is 30 per cent.; if it loses 1,200 workers a year, its labour turnover will be 120 per cent.

The losses resulting from a high labour turnover are enormous. In an investigation conducted by the National Institute of Industrial Psychology in 1938 into labour turnover, in ninety-five firms it was found that eight of them had had an annual percentage rate of loss for women of over 100. Sargant Florence in his excellent study of this subject says:

"Calculations made in England based on a turnover rate of 100 per cent. and a loss per case of turnover of £2 10*s*. to the employer and £2 10*s*. to the worker bring out the aggregate loss among the twenty million employed in industry as £100,000,000. If the average wage is taken as about 45*s*. to 50*s*. a week, say £125 per year, this would indicate a loss of 4 per cent. of the pay roll equally divided between master and men. The loss to the employer is here very conservatively assessed and the American experience of 5 per cent. of wage bill gone in 'friction' for a 100 per cent. turnover is probably in fact approached." *

The high cost of labour turnover is made up in various ways:

The chief cause is generally from the direct loss of output. Some research on this subject has been conducted by the National Institute of Industrial Psychology. At a certain factory where the labour turnover was 105 per cent., it was found that the average daily output of new

* *Economics of Fatigue and Unrest* (Allen and Unwin, 1924), pp. 159–60.

workers increased steadily up to their twentieth week in the firm, after which approximate equilibrium was attained. The average length of stay of workers leaving within the two years' period of the research was found to be fourteen weeks, and the potential average output lost per worker was equivalent to an output of approximately eleven days' work. In addition, it must be remembered that an increased amount of spoiled work and of accidents is incurred by new workers. Loss is also due to the cost of the time taken by the employment department or foreman in interviewing and discharging the workers and of the clerical work involved. The time taken by the foreman in training and supervising the new workers must be added to the expense. Other losses are of a more intangible kind—the reputation and the *esprit de corps* of a firm, which have a direct relation to its labour turnover.

But apart from financial losses, a high rate of labour turnover has a serious effect on the social life of the community. The psychological effect of dismissal on a worker is often to load him with the burden of conscious incompetency. The boy who starts from school fresh and eager to work, will after one or two dismissals become a very different person. In fact the desirability of reducing the labour turnover is as important from a social as from an economic standpoint.

Methods of Staff Selection

Ther are three fields for selection in the average industrial firm, raw materials, machinery and staff. The raw materials are generally subjected to the most rigorous tests in the firm's laboratory before they are accepted, and the different markets are vigilantly compared by the buyers. The claims of rival firms of machinery makers are closely studied by skilled engineers before even a small piece of new plant is bought. But the choice of the staff—surely the life of the business—is often left to an unskilled minor executive who has no special competence or knowledge.

There are various causes for this curious negligence. First, it has only recently been fully realized that individuals differ in their innate aptitudes for different occupations. " He looks a nice bright boy, we will take him," would be said. Such general judgments would be made for many types of work, without realizing that a boy might be " nice " and " bright " too, but yet not have the other particular attributes suitable for work as an engineer, a clerk or a salesman, or whatever might be the post for which he was being chosen.

Another cause for negligence in staff selection is that a certain number of business people still consider themselves " born psychologists," or any rate believe that they have a sort of natural

intuition or an acquired skill for selecting staff, which is so accurate that it cannot be improved by any scientific method. The industrial psychologist fully realizes the value of that psychological *flair* which is inborn and of that psychological knowledge which can be acquired through experience; but he knows that these can be usefully supplemented by systematized study and standardized methods. Scientific methods of selection have been steadily developed during the last twenty years, but many industrialists are still ignorant of their utility.

The most usual mode of engaging staff is to hold a personal interview with the applicants. A survey of thirty firms employing 55,000 persons, made by the Vocational Bureau of Boston, showed that twenty-one of these firms always made use of an interview in selecting workers, three generally used this method, and six occasionally used it.

An interview is certainly a valuable method of selection. It gives some indication of intellectual ability, and it is, up to the present, the most satisfactory means we have of assessing temperamental qualities. Indeed it is probable that in whatever degree tests for intelligence and for temperament may be perfected, they will never be able to supplant the interview. The term "personal interview" may cover anything from the curt "Name? previous experience?" of a busy foreman, to the long and carefully

thought-out conversation of a skilled employment officer. If full use is to be made of the interview, it must be systematized both as regards the methods by which it is conducted and the means used for recording the impressions. A fuller account of the technique of the interview will be given later in this chapter.

But even when given in the best possible manner, the interview has many limitations. The most serious of these is that there are many abilities not susceptible of observation at an interview. An impression can be received of the applicant's general intelligence and of certain temperamental factors. But that leaves great gaps in the picture of his mental life. There are many special abilities to be assessed before it can be known that the applicant will be suited to the occupation; and many of these abilities cannot possibly be observed at an interview. One cannot, for instance, assess the fine muscular coordination desirable in a draughtsman by the slope of his nose or by the neatness of his tie. How can one assess the probable speed or accuracy of working in a girl applying for apprenticeship at dressmaking by her ways of walking or talking?

Another limitation of the interview method of election arises from the difficulty in keeping the nditions comparable for different applicants. ually no attempt is made at standardization her in giving or assessing the results of the

interview. But even when such standardization is attempted, the interview is still so dependent on the interaction between the two personalities that it is extremely difficult to eliminate all extraneous prejudices. The interviewer himself, being a living person, cannot possibly be the same at all times. Anyone who has done much interviewing knows that he is in a very different condition of affability when interviewing the fifteenth candidate than he was when interviewing the first. And an applicant coming after a good candidate may have quite a different reception from that he would have received if he had come after a poor one.

A certain number of employers frankly realize the inadequacy of the interview as a means of selection and prefer to depend rather on the system of probation or choice by trial and error. They claim that the only way you can tell an applicant's ability is by actually trying him for some time on the job. Undoubtedly this must always be the ultimate test of ability, but for many reasons it is undesirable for it to be recognized as the only way. First, it is nearly always necessary to make a choice of those who are to be put on probation. There are ten applicants, and four jobs to fill. How will you select which four to try? Without some reliable method of selection it is likely that a good man will not have the chance of being placed on probation.

Another disadvantage of probation as the sole

means of selection is that in actual practice it is generally only the very unsatisfactory workers who are dismissed. There is a natural dislike among the average foreman to report unfavourably against a new-comer. Flagrant cases of unsuitability are certainly dismissed; but if a boy is "slow but willing," he is often kept on, although, as he will never make a success at the job, his appointment is neither in his own interest nor in the firm's. On the other hand, if a firm rejects all workers found after probation to be unsuitable, it will suffer from the bad effects of a high labour turnover, which have already been described.

Scientific Methods of Selection

We conclude, then, that the careful selection of workers is of paramount importance for the success of the firm, and that the selection methods at present in use are inadequate and uncertain. How these methods can be improved is a problem that is now being studied by industrial psychologists. The ideal to be aimed at is some method of obtaining an exact measurement of the presence or absence of the various mental and physical abilities required for efficient work in any given occupation.

The most direct method of obtaining this measurement is to give a sample test, that is, a task very similar to the job—perhaps an actual specimen of it—but given under standard con-

ditions. Such a test, it is assumed, measures simultaneously all or most of the abilities required for the job. We may test the typist at her typewriter, the chauffeur on his car. Such a test is essentially a very short probation given with standardized procedure. The test is applied to different candidates in exactly the same manner with carefully phrased instructions, their success being measured according to a prepared scale and interpreted by norms obtained from a large number of the results. The sample tests first used by the American Army in 1917 to discover whether men applying as experts at skilled jobs were up to standard afford good examples of this method.[30]

But sample tests have one great disadvantage; they measure acquired skill as well as innate ability. They are of no use, therefore, for testing beginners, or for comparing individuals with different amounts of training or experience, or who have been used to slightly different apparatus. Since selection tests are largely used for choosing beginners, it follows that some other method is required, and it has been found that "analytic tests" are the most satisfactory. With analytic tests the ability to succeed in the occupation is analysed into its component abilities, and then each ability is tested separately.

At the present stage of our psychological knowledge, such "occupation analysis" is necessarily incomplete and inexact; but it cannot fail to

give some sort of guidance to the subsequent preparation of the tests. The terms in which the analysis is made should be as precise and definite as possible ; naturally the relative importance of the different abilities must be stressed.

When the analysis has described the abilities that are desirable for the occupation, then comes the problem of discovering to what extent these abilities are possessed by the applicant. This is usually done by means of separate tests. Tests are essentially short tasks which require the same ability for their performance as that which is required in the occupation, but which can be presented under more standardized conditions and allow of more exact estimation of results.

Since analytic tests have been more used in this country for the purpose of selection than any other kind of tests, it will be well perhaps to describe the method of preparing these tests and the precautions that must be observed.

In a typical investigation a psychologist goes to the firm requiring the tests, and first decides whether tests would be useful and practical for that occupation. In this he is guided by (*a*) the size of the department, (*b*) the extent of the labour turnover, (*c*) the probability that the abilities required for success can be accurately enough measured by tests, and (*d*) the choice of applicants—that is, the number of applicants compared to the number of workers employed. If and when he decides on a department in which

to work, he immediately makes his purpose known to the whole of the staff concerned, both managers and workers, so that he can obtain that co-operation from them which is essential for the success of the work.

The actual preparation of the tests must be preceded by an occupation analysis. There are several ways of obtaining information for this analysis, all or most of which should be used. First, the successful and unsuccessful workers should be observed to see the causes of their differences. This observation may be direct; or it may be indirect, e.g. by slow-motion cinematograph or by experimentally hampering certain movements. As much information as possible should be gained from the experience and observations of the manager, foremen and workers. Finally, the psychologist himself should learn the work, for much can be found from introspection that could never have been learnt from observation. While the analysis is being made, the psychologist should spend as much time as possible in the department, so that he can "soak in the atmosphere" and thus realize the more intangible, temperamental requisites of the work as well as the more obvious ones, relating, say, to intellectual, sensory or manual ability.

When the analysis has been completed and the abilities have been discovered which seem to distinguish the good workers from the poor ones, tests must be found to measure these abilities.

When satisfactory tests are already in existence, they should if possible be used ; if there are none, then new tests must be devised.

A decision must be made as to whether the tests are to be applied to groups or to individuals separately. A group test has the advantage of speed, but is ordinarily a less sensitive and accurate instrument than the individual test. A further decision has to be taken as to the material of the tests—pencil-and-paper tests or oral tests. A safe rule here is that the form of test should as far as possible resemble the form of material used on the job : test the engineer by performance tests, the clerk by pencil-and-paper tests, and the salesman, partly at any rate, by oral tests.

The fundamental requisite of a test is that the same ability should be employed in its performance as that which has been found by analysis to be important for the work. It should also be of the requisite degree of difficulty for the applicants who will take it. Preferably it should be so constructed that few, if any, get full marks, that all get some marks, and that the majority get about 50 per cent. of the marks.

The chief characteristic of a psychological test is its uniformity—both as regards performance and scoring. It is this characteristic, incidentally, that chiefly appeals to the workers, who often comment on the increased fairness of the psychological method. In order to ensure uniformity,

care must be taken that performance at one test is not influenced by any previously acquired experience or practice which may be possessed by some of the candidates but not by others, and which is not directly useful for the work.

Great care must be taken to see that the instructions are so framed that all the candidates understand exactly what is required of them. They should be standardized, so that all the candidates have an equal amount of help, and so that the procedure is the same for different examiners. Before any test is used, the instructions must be tried with people of a level of intelligence similar to that of the candidates, so that possible ambiguities can be removed. It is advisable also to supplement the instructions by examples and by trials at the test.

A good test should be completely objective as regards scoring; it should be framed so that no personal judgment is needed to assess the results, and different examiners are thus certain to give the same mark for the same answer.

When a test is being used for industrial purposes, it is not enough to consider its effectiveness and its uniformity—its convenience in use must also be studied. Many a test suitable in the laboratory is unsuitable in a business firm. Primarily there arises the question of economy of time, both in setting and scoring the tests. All precautions should be taken to prevent nervous- on the part of the candidate: it is well to

start with easy tests to give the applicant some assurance. Fatiguing tests should be avoided, or at any rate placed at the end of the series. As far as possible, the tests should be made interesting and their connection with the occupation should be stressed by giving them an outward and obvious resemblance to the job: make a tin machinist's test out of tin, provide for sweet-packers a form board in which the loose parts look like sweets.

When the psychologist has drawn up a series of tests, he has done but half of his work; he still has the onus of proving their worth. He must "try out" (or test) the tests on a suitable group of workers to see if a satisfactory relation obtains between their performance at the tests and their efficiency at the work. There are various methods of making this comparison. Probably the most accurate is to test a number of applicants, to absorb them in the firm, and after they have been in the firm some time to compare their performance at their work with their performance at the test, and to see whether, if the test results had been used, the best workers would have been chosen and the worst workers rejected. But this method of testing the tests takes a great deal of time, and it is generally more convenient to obtain a preliminary indication of the value of the tests by applying them to a group of workers already in the firm. Various estimates of the relative ability of these workers can be obtained

—in some cases a direct measure of their average weekly output, in other cases a comparative ranking from a foreman or manager who knows them well. The accuracy of the test is measured by comparing the ranking of the workers according to the tests with their ranking according to the chosen standard of their efficiency at the work.

No series of tests can ever be considered perfect. The proof of their value lies in their practical results, and therefore it is necessary to follow these up, and constantly to check and re-check their discriminative value.

The Standardized Interview

Our knowledge of tests is still at an early stage, and there are many abilities—particularly temperamental abilities—that cannot be measured by tests. To gain a more complete picture of any individual, it is necessary to supplement the tests by an interview. The very nature of an interview makes it impossible to standardize it as one can standardize tests. The essence of a test consists in a standard evaluation of behaviour under standard conditions. In an interview the conditions cannot be standard; but the evaluation can be, at least partially, standardized.

In preparing a standardized employment interview, the first step is to make an analysis of the qualities to be observed. This can be prepared in the same way and at the same time as the

occupation analysis which is made before the tests are devised; but here those abilities are stressed which can be observed at an interview. Often it is of assistance in the analysis to have two main divisions of abilities—those relating to people and those relating to work. It is important to define the abilities which are to be observed as exactly as possible—not, for example, to use such vague words as "reliability" or "personality."

Perhaps the most important part of the technique of an interview is to put the applicant at his ease. Special care should be paid to the interviewer's manner of speaking, his introductory remarks, and the arrangement of the room in which the interview takes place. The interviewer should prepare beforehand a rough scheme of his part of the interview. This has two advantages—it leaves him free to make observations instead of having to think out the next step in the interview, and it enables him to plan questions which are most likely to evoke replies revealing the presence or absence of those abilities which were found in the analysis to be requisite.

For recording the impressions gained at an interview, a standard scale should be used. The simplest satisfactory scale is to have five divisions A, B, C, D, E, and to allot one of these marks to each quality sought for in the candidate. The standards should be so arranged that in a

large group of candidates some of them, say 10 per cent., get an A or an E mark. A larger proportion of the candidates, about 25 per cent., should get B or D marks, and the remaining 30 per cent. of the candidates should get C marks.

An even more satisfactory method is to use "graphic rating scales." In this scale a horizontal line is drawn with descriptions of the various degrees of the ability written at intervals below the line. For example a rating scale for "co-operativeness" might run thus:

Co-operativeness. Think of his ability to "work in with" the other members of his section. People are of all degrees of co-operativeness from those who are selfish, bad-tempered, jealous, to those who willingly share the load and help other people in their section all they can.

Is a source of friction	Indifferent	Fits herself in	Helpful to fellow-workers	Extremely loyal, useful worker

The interviewer expresses his opinion of the degree of this quality possessed by putting a mark at the corresponding point along the horizontal line.

The possible number of graduations is therefore infinite, although for scoring purposes the line is divided into a convenient number of divisions. The chief advantage of this method of rating is

that most people find it easier to express their views graphically rather than numerically.

In interviewing an applicant, ratings will have to be made for a number of qualities before his final rating as to " general suitability " is made. This final rating may be the mean of the other ratings, or it may be made independently. But in any case the previous work of having made each of the other ratings will have ensured that all the relative qualities have been considered, and that one prominent quality is not given an opportunity of unfairly prejudicing the results.

The relative importance of the test and of the interview has to be considered separately for each occupation. For some occupations very accurate tests can be made; in others the interview is more important. In one big retail store which consulted the National Institute of Industrial Psychology, it was found advisable to give the results of the tests and of the interview equal value in the case of the shop assistants, but in the case of the clerical staff to assess the tests at 75 per cent. and the interview at 25 per cent.

The Present Position of Vocational Selection

Vocational tests have now been used for many years. They have met with approval from both employers and trades union leaders, for they have proved of practical value in decreasing learning time and labour wastage and in increasing the standard of production. They are useful

even when there is a labour shortage, for they assist in the decision that always has to be taken on the placement of those applicants who are available.

Some people indeed have been over-enthusiastic and have tried to introduce selection tests without taking the necessary precautions. Experience has shown that testers always need some tuition, however simple and "fool proof" the tests may seem.

During the War all three of the Service Departments have developed the use of selection tests as aids in assessing the recruit's aptitude for the various arms and branches of the Service. The information gained by the widespread use of this procedure should give a great stimulus to the extension of the use of selection tests after the War.

To sum up, if the wrong tests are used, or if the tests are applied incorrectly or as the only method of engagement, they may do more harm than good, but if the tests are properly selected and standardized they form a very valuable part of the engagement procedure and prevent the most tragic of all sources of loss—the loss of human ability.

CHAPTER XI

INDUSTRIAL PSYCHOLOGY AND WELFARE WORK: DOES OVERLAPPING OCCUR? THE CASE STATED

By Sheila Bevington

It sometimes happens that a director claims that his factory offers no scope for the industrial psychologist, inasmuch as a welfare supervisor has already been engaged to perform similar functions. On enquiry the director may give some such account as follows of the motives underlying this appointment. He will probably explain that his firm did not employ such an official before the 1914–18 War, but that since then the problem has become more acute and in consequence a whole literature has arisen on the subject of industrial relations. The main theme of these writers has been that better industrial relations can be promoted only by giving more consideration to the human factor in production. Since this director's own judgment, based on handling men both under peace and war-time conditions, confirmed this theory, he has persuaded his firm to appoint a welfare supervisor. By this means, and for the first time, the rank-

and-file worker is afforded direct and easy access to a member of the higher administrative staff, specially appointed to consider questions affecting his well-being. In course of making such contacts daily, the welfare worker must necessarily become aware of any defects in working conditions or of excessively fatiguing processes such as those with which the psychologist concerns himself. Such matters he would be expected to report for remedy. Even were these contacts alone insufficient, the supervisor's additional responsibility for watching sickness and accident records further emphasizes the risks peculiar to certain processes.

Our director may thus briefly dispose of the case for employing an industrial psychologist to investigate such problems of workshop environment as those dealt with in previous chapters. In answer to further questioning he may with equal vigour refute the suggestion that a psychologist's assistance would perhaps prove useful in the matter of vocational selection. He may explain that his welfare supervisor has already specialized in the practice of engaging and transferring labour. It may, moreover, be argued that he has an advantage over the psychologist in knowing the special requirements of each process in relation to the neighbourhood possibilities of supply. Since the firm's rate of labour turnover is below the average for the district and a very fair type of labour is attracted, wherein lies

the advantage of retarding the selection process and increasing its cost by the introduction of tests ?

Plausible, if specious, arguments can be advanced along these lines. Should our interrogator persist in asking the director who fulfils the industrial psychologist's functions in respect of training, movement study and so on, he will doubtless be informed that such matters fall within the respective spheres of managers, foremen or engineers on the regular staff.

Fortunately for the prospects of industrial advance, as well as of social progress, such blindness to the advantages and such ignorance of the methods of systematic and expert research work are rapidly disappearing. Indeed it may practically be said to have disappeared already in regard to the usefulness of industrial chemistry and industrial medicine. In the course of the present generation a similar change of attitude is predictable with reference to the work of the psychologist and physiologist in factories.

But yet, the reader may object, is there no ground whatever for the director's contention that the functions of the psychologist and supervisor do occasionally overlap ? Since both functionaries claim to be chiefly * concerned

* Certain aspects of the psychologist's work, such, for instance, as that of reducing waste of material, have a remote rather than a close bearing on the worker's welfare.

with improving the lot of the human element in the works, is not some further explanation required as to the different contributions which each offers to industry?

The Difference in Approach

In order to examine the difference in approach to what is admittedly a problem partly common to both these officials, their respective training, status and terms of reference must be considered. The industrial psychologist may rank as a permanent member of the works staff in exactly the same sense as does the welfare supervisor, for some progressive employers already retain the full-time services of a psychological staff. But since in this country, at any rate, the tendency is rather for employers to requisition the services of visiting psychologists from certain scientific bodies, it is the position and function of these investigators which will be hereafter reviewed.

By education, then, the psychologist (be he man or woman) is a University graduate, who has undergone additional training (both practical and theoretical) in the methods of industrial and vocational research. The fully-trained * welfare worker, on the other hand, generally spends two

* Although such training has long been regarded as a pre-requisite for membership of the Institute of Labour Management and also as desirable by the Industrial Welfare Society, some employers still appoint, as welfare supervisors, men and women without academic or even other relevant training.

years in taking a University diploma in social science. Part of this period is devoted to gaining experience in practical work, if possible inside a factory welfare department.

The shorter training-period thus required for welfare work, as contrasted with Industrial Psychology, tends generally to reflect itself in terms of salary and hence ultimately in the calibre of recruits. In turn, all three of these factors react on the relative status of the welfare supervisor in the works. Of this fact any individual who has served in both capacities is speedily made aware. The proposals of the investigator usually receive prompt and careful consideration, not only as coming from a specialist whose advice will not always be available, but also because they are expected to have definite economic value. On the other hand, the weight carried by the proposals of the welfare supervisor depends rather on his personality and length of experience in a given firm than on any body of specialized knowledge which he is recognized as possessing. Not infrequently in urging his suggestions the supervisor lays stress rather on the social than on the economic desirability of the changes which he advocates. Even when the economic advantages of the supervisor's proposals are emphasized, systematic attempts are seldom made to shape them in terms of expected saving ; still more rarely perhaps are the results subsequently evaluated. In these

circumstances it is perhaps hardly surprising that long delays are often incurred between the first formulation of a proposal and its actual enactment. Indeed it may easily happen that an excellent proposal made by the supervisor on grounds of social desirability is shelved for years by the employer on the score of the outlay which it involved. Ultimately if a psychologist visiting the firm has the time to collect the data necessary to show that the proposal is also desirable on economic grounds, the change may be rapidly introduced.

In arguing along these lines, it is not intended to reflect discredit either on the principles of employers or on the methods of welfare supervisors ; both are to some extent the victims of circumstance. The employer may agree that the carrying out of certain changes in his organization is socially desirable ; but (in the absence of supporting data as to the probable outlay and returns) he does not feel economically justified in recommending them to his board. The welfare supervisor, in his turn, may be fully convinced that the enactment of his proposals will well repay the firm financially ; but he has neither the time, opportunity nor specialized knowledge to collect and present the necessary data. Moreover, it would appear that on account of his training and outlook the welfare supervisor (even although employed in a firm of which the avowed primary object is the earning of dividends) tends

to advocate socially desirable changes primarily on the basis of principle, without emphasizing their economic justification.

Not only then does the training, but so also do the terms of reference and the method of approach of investigator and supervisor, differ widely. The investigator is usually called into a factory to study either some special department or the various aspects of some particular problem. Having made his observations,—time and motion studies and so on,—he will arrive at certain hypothetical opinions. He will then need to test the validity of these opinions by altering various factors in the situation, one by one, and noting the results. In order to obtain the necessary facilities for his experiment he will apply to the director who is sponsoring his enquiry. Supporting figures and arguments will be submitted ; whereupon, in order not unduly to prolong the investigation, facilities are usually granted with as little delay as possible. Subsequently the experimental results will be reported, so that the director can judge whether or not a more general extension of the change is financially justified.

Objections may here be raised that the experimental method of approach just described is by no means new to industry, inasmuch as engineers and chemists have long worked along similarly scientific lines. While this fact is readily admitted, nevertheless the application of similar

methods * to the human, as distinct from the material or mechanical factors in production is of recent origin. Hitherto practically the only systematic attempt to report on the workers' reactions to changed conditions has been made by the welfare supervisor. It has usually been formulated in the shape of generalizations based rather on individual workers' statements than on any more exact enquiry. Indeed when the long tale of duties entrusted to a typical welfare department is considered, it will immediately be recognized that only scanty time remains for the collection of experimental or other statistical data. While the complement of welfare departments varies somewhat (apart altogether from the number of workers employed), the welfare-staff in a works employing one thousand persons, mainly members of one sex, would probably average one supervisor, a nurse and one or two clerks. The usual duties entrusted to this staff may be briefly enumerated under the headings of employment, health, food and working conditions.

The work of the welfare department embraced by the term "employment" is mainly the engagement of labour, certain duties in connec-

* While in Great Britain such experiments have usually been carried out by psychologists, in the United States and many parts of Europe engineers have carried out similar inquiries in the course of introducing "scientific management" or "rationalization" schemes.

tion with its transfer and dismissal and the keeping of employment records. While, on the one hand, the supervisor must be accessible for consultation by any worker on a wide range of problems, on the other hand, his or her services are usually liable to be requisitioned by the forepeople in certain disciplinary matters.

Under the heading of " health " is involved the running of the ambulance room. Besides the rendering of first-aid, provision has to be made for visiting sick absentees, the recording of accidents and of sickness causing absenteeism, and the preparation of new applicants for medical examination. In addition, responsibilities in connection with the administration of dental or ophthalmic schemes within the works are becoming an increasingly usual feature of welfare work.

The department's duties in connection with the " provision of food " may range from the arrangement of mess-room facilities to the administration of a large canteen, entailing ultimate responsibility for the supervision of its staff.

In connection with " working conditions," the welfare supervisor accepts responsibility for the provision and maintenance by the cleaning staff of adequate standards in sanitation and cloak-room provision. In addition, he or she usually visits the workrooms, and supervises working conditions from the standpoints of health and

cleanliness. In this connection, additional duties regarding the supply of protective clothing are frequently involved.

The welfare department will also be charged with duties arising out of such miscellaneous activities of the firm as: sports clubs, initiation schools and foremen's training classes, benevolent and pensions schemes, savings bank collections, safety-first propaganda and holiday payments. Should the trade be one to which a Home Office Welfare Order applies, the supervisor is usually held responsible for seeing that its provisions are carried out. If minimum-wage standards are also enforceable under the Trade Boards Act, the duty of watching and following-up low wage earners is frequently entrusted to her. Often enough one of the supervisors further shoulders the exacting position of Secretary to the Works Committee.

Although, as mentioned above, the allocation of duties will necessarily vary somewhat according to the circumstances prevailing in different works, it is reasonable to estimate that at least two-thirds of this programme will be undertaken by the welfare department in a concern employing one thousand workers. In addition, the welfare supervisor's advice is constantly being sought by the directors and managers on matters of labour policy. Undoubtedly at this point the reader will exclaim that with such a schedule of duties a welfare staff of these dimensions must

already be seriously overburdened. How then can people working at this pressure (and seldom enjoying more than three weeks' annual leave) expect to maintain that poise and freshness of outlook which is so essential to the handling of personnel questions, or to the promotion of smooth industrial relations? Surely the adequate performance of so vast a programme must entail inroads on the supervisor's leisure which will seriously deplete the amount necessary for recreative and cultural purposes? The consideration of such questions however lies beyond the scope of the present chapter. The only object in presenting the above-mentioned facts is to show that the welfare supervisor has not the time to undertake the additional work needed for a psychological investigation. It is obvious that in order to carry out such enquiries in a scientific fashion, the investigator must be able to concentrate uninterruptedly on his problems. Not only is such disposal of his time impracticable for a welfare supervisor, but so is it also for any member of the regular administrative staff. In these circumstances any proposals offered by the supervisor on problems of lighting, ventilation, heating, etc., will carry a weight varying in accordance with his reputation for shrewdness and practical experience; they must necessarily be less reliable than those advanced by the industrial psychologist on the basis of statistical measurement and experiment.

Co-operation and Kindred Interests

If, however, the welfare supervisor cannot undertake the industrial psychologist's researches and if, as is clearly the case, the latter cannot shoulder the former's wide range of responsibilities, their need of one another's help is mutual. On arriving at a works to undertake an enquiry into environmental conditions, the investigator will naturally wish to consult the supervisor's records of sickness and of accident-absenteeism. Over and above these written records, moreover, the supervisor may be able to give him valuable information, which will materially speed the progress of his enquiry, about the underlying situation in certain shops. The firm may with advantage definitely encourage their supervisor to discuss with the investigator outstanding problems of environment and selection. Apart from being able to give specific help in these directions, the investigator can often pass on useful information, with regard to technical reading matter and to the handling of certain welfare problems by other firms.

When the period of his investigation is drawing to a close, the investigator is occasionally beset by uneasiness lest the changes which he has introduced (but which have not perhaps had sufficient time to crystallize into tradition) may be upset by some trivial mischance. He may choose to leave their oversight and maintenance in the

welfare supervisor's hands. Instances of this kind will probably occur in connection with the adjustment of work-chair heights, the regulation of ventilation, the right use of rest pauses, and so on. If, furthermore, the investigation has been of a vocational rather than of an environmental character, the supervisor may be entrusted with giving the resultant selection tests.

Future Developments

The position of the welfare worker, like that of the industrial psychologist, is still far from standardized. Some firms tend to give him definite responsibilities on the production side, others to centralize certain functions and to delegate those remaining among departmental supervisors. While both officials are new-comers to the industrial field, the psychologist is the latest arrival. In the past the welfare worker has directed his employer's attention to the workers' need for expert service from the dentist, the oculist, the games instructor and so on. As the value of the psychologist's contribution to industry becomes more widely recognized, the supervisor will confidently ask for his services in such matters as improving environment, raising the earning capacity and standardizing the training of the various employee groups.

Variants of the present visiting status of the industrial psychologist in this country are sure to

arise sooner or later. Mention was made above of a few firms which already employ whole-time psychologists as permanent members of their staff: others are sometimes employed on long-term contracts, e.g. from the National Institute of Industrial Psychology. Yet other firms are considering the appointment of vocational psychologists as welfare workers specializing on the employment side. In such cases some previous study of economic history and sociology should be required of the psychologist, just as in the reverse case the welfare worker should be required to qualify in psychology and scientific method. Again, too, the work of the investigator is likely to become more highly specialized in its various aspects of environmental study, study of methods, of industrial relations and so on. In this respect it would run parallel to the development of the welfare staff's organization in some large firms.

But since the future lines of development remain uncertain, further speculation as to their direction is at this stage unprofitable. One conclusion seems justifiable—that the cause of workers' (and so of employers') welfare is better served by the simultaneous, co-operative work of the welfare supervisor and the industrial psychologist than by either of these individuals functioning solely and separately as independent units.

CHAPTER XII

THE ECONOMIC ASPECTS OF INDUSTRIAL PSYCHOLOGY

By F. W. Lawe

"EASE of work brings speed of work": this phrase more than any other typifies the outlook of the industrial psychologist. It makes clear the double significance of the new science. First, through its studies both of working conditions and of vocational fitness, Industrial Psychology is seeking to remove unnecessary mental or physical strain, and is helping man to adapt himself to the Machine Age. Secondly, through its effects in increasing production and in reducing waste, both human and material, it is achieving economic results hardly less important than its directly human benefits.

The flow of wealth is dependent on the speed and economy with which productive work can be carried out. The mechanical and technical sciences have already harnessed the material energy of Nature in the service of wealth production; the human sciences of psychology and

physiology have now entered the industrial field to ensure that the physical and mental energies of man are used to the best economic effect. The prodigal wastes of energy, of time and incidentally of material, due to the neglect of the scientific study of the human factor, restrict unnecessarily the production of wealth.

In 1921 a national campaign was inaugurated in America by Mr. Herbert Hoover against the material wastes involved in the multiplicity of styles, designs and descriptions of the products of each industry. In England valuable work had been done on these lines many years before by the British Engineering Standards Association. But Mr. Hoover expanded this movement into a nation-wide campaign for simplification and standardization. The repercussions of such a policy are obvious. In choosing, for instance, the best design for electric bulb sockets, and in reducing the number of varieties from 179 to 6, the manufacturers not only reap a benefit themselves in the easier and cheaper organization of production and of selling, but at the same time they assist the efficiency of retail trade by reducing the range of stock carried and by simplifying the mental effort of the purchaser. This great movement towards the elimination of certain *material* wastes points the way to an attack on the *human* wastes of industry.

Vocational Guidance

The greatest human waste of industry is caused by the lack of adequate vocational guidance. Improvement in the methods of placing the right man in the right job will undoubtedly result in the increased efficiency of the whole economic machine. Even the most haphazard method of engaging workers aims at securing the best for the job ; but a modern employment department, aided by psychological selection tests, can be more certain of correct placement. A higher level of production per head naturally follows. This means lower overhead costs per unit of the product : and American experience has shown that a progressive lowering of overhead costs leads to higher wages and profits combined with lower prices.

Although the main economic interest of the application of vocational psychology is the better utilization of the available human abilities in production, there is a further economic result in the reduction of labour turnover. The burden on industry of the costs of labour turnover (i.e. the rate at which employees are engaged and discharged) is not sufficiently realized. If the wrong man is placed in a job, he either does it badly or leaves it quickly, and in either case the cost of production is increased. The engagement of inexperienced new workers to

replace those who leave involves the cost of the instructor's time and of that of the official who makes the engagement; it involves also a loss of output and a consequent higher overhead charge on production during training, besides the cost of spoiled work and of accidents, which are naturally most frequent amongst inexperienced workers. Direct attention is never called to these costs by the normal accountancy methods of industry; they are consequently a hidden charge on the cost of production. The magnitude of the annual loss in Great Britain from this source is estimated by Sargant Florence at one hundred million pounds sterling.

Vocational psychology does not of course confine its study to manual workers, although until quite recently research work has dealt mainly with the simpler occupations. As the higher occupations are brought within its practical range, its usefulness will multiply. Taussig, in his *Principles of Economics*, stresses the great importance of good leadership in industry. "All progress, material as well as spiritual," he says, "depends on the selection of the right leaders," and again: "Leaders are rare. Most men are commonplace. Among the means for promoting progress none are more important than the discovery and stimulation of those who have high abilities." The problem of how leaders may be discovered and stimulated is surely a problem in psychology

rather than in economics. It is being seriously attacked by the National Institute of Industrial Psychology through the study of the measurement of intelligence and of special aptitudes, and through researches into the psychology of incentives to work and the influence of temperamental factors on vocational success.

If the study of vocational fitness is important to the economic life of the nation, no less important is the study of the methods and environment of the worker at his work.

Fatigue

The science of Industrial Psychology aims at promoting that ease and smoothness of work which leads naturally to increased speed of output. The instances of increased output with reduced "real costs" in mental and physical fatigue given elsewhere in this book are sufficient indication that, in addition to the human gains, most substantial material gains will accompany the expansion of the field of work of the new science. On the information at present possessed, it is impossible to estimate exactly the magnitude of the gains which are immediately practicable; but the economic history of the last century proves that reduced costs of production provide the greatest stimulus to the expansion of industry. Industrial Psychology leads directly to such reductions.

A large proportion of our economic ills have

recently been laid to the charge of a supposed policy of *deliberate* restriction of output on the part of trades unions; yet the fact seems to be that the objections of the unions are concentrated, not on the policy of increased output in itself, but on attempts to "speed up" the worker to a pace deleterious to his health and to his ultimate efficiency. The industrial psychologist works on the theory that higher production should be attained through the reduction of strain and through the removal of unnecessary hindrances to output, i.e. by that organization of work which pays *scientific* regard to the human factor. This is Scientific Management in the truest sense of the term. It is the experience of the National Institute of Industrial Psychology that its investigation work in factories has induced a new outlook on the part of the management—a realization of human values and of the great economies and increases in productivity to be derived from the consideration of the workers' point of view.

Sickness and Accidents

Absence from work through sickness and accidents constitutes a heavy charge on industry. It is an obvious limitation to the production of material wealth. The average annual loss of time due to this cause in the years 1922–4 was 28·79 million weeks compared with the annual

loss of 2·17 million weeks due to trade disputes.* Directly or indirectly, this represents an additional charge on costs of production of at least fifty million pounds per annum.

In the light of the modern developments of medical science, there can be little doubt that nervous causes connected with wrong conditions of work are responsible for a considerable proportion of the sickness and accidents. That the Government is alive to this fact and to its proper treatment is proved by the establishment, under the Medical Research Council, of the Industrial Health Research Board, of which one of the main objects is "to study on systematic and scientific lines the laws governing the healthy employment of the human mind and body in industry."

A high sickness or accident rate in one department of a factory is regarded by the industrial psychologist as *prima facie* evidence of the necessity for enquiry into the working conditions. Where the cause is to be found in the working conditions, careful study will most frequently reveal methods of amelioration. The spells of work may be too long or too monotonous, the ventilation may be at fault, or the lighting may be defective, leading to eye troubles. There is evidence that the economic losses in industry

* *Survey of Industrial Relations*, Committee on Industry and Trade (H.M. Stationery Office, 1926), p. 165.

due to uncorrected and aggravated defects in vision are very high. Sometimes the causes are more subtle; e.g. nervous disorders may well arise when a machine is working too fast or too slow for the natural rhythm of the worker who has to operate it; or they may be developed in such a mental "atmosphere" as prevailed in a certain shop where one worker remarked bitterly, but with truth, "the wind is always in the north-east here."

If the reduction of the heavy financial charge of sickness and accidents on industry does not provide a sufficient reason for the active expansion of Industrial Psychology, the possible improvements in health itself surely form a conclusive argument.

Home Conditions

The influence of the worker's living conditions at home are, of course, of the greatest importance to his efficiency in the factory. Even in this direction Industrial Psychology has something to offer, for the principles of the science can be applied to the home as well as to the factory. In endeavouring to eliminate the wastes of energy due to the persistence of inefficient traditional methods of performing household tasks and to faulty planning and design of the home, it is more than possible that a valuable contribution can be made to the effectiveness of the home as a place of rest and recreation.

Industrial Disputes

If further psychological study results in a better understanding of those industrial mental disorders known as strikes and lockouts, it may serve well the economic life of the nation. Between 1900 and 1935 an average of 14,505,750 working days were lost each year in industrial disputes.* There can be little doubt that a large proportion of this loss has been due to the inept handling of men and situations, or to the direct conflict of strong personalities. Expert study of the psychology of negotiations and of industrial relations may well lead to an improvement of technique which would prevent a minor irritation from becoming an open sore.

Advertising and Design

All the matters so far dealt with in this chapter concern the very basis of the economic well-being of the nation. In other fields of work, perhaps not of such first-rate importance, the industrial psychologist is giving food for thought to the economist.

For instance, it would be admitted that advertising is to-day a directive force in creating and controlling demand; it does, in fact, influence greatly the distribution of goods and is capable of creating entirely new " demands."

* Annual Abstracts of Labour Statistics (H.M. Stationery Office), *passim*.

It is also realized in a general sense that advertising depends on the practical application of psychology. But the extent to which the results of psychological research and the methods of the psychological laboratory are available is certainly not adequately known, even in the advertising world. No firm would buy large quantities of raw materials without careful test and guarantee. Yet a firm which employs a large staff in its chemical laboratory will accept a huge advertising scheme " on trust," without realizing that scientific sampling is also possible here by carefully controlled experiments in the psychological laboratory.

Allied to the subject of advertising is that of the design of the product and of the wrapping in which it is marketed. Here also psychological methods are used to determine the forms which have the greatest " attractive " and " persuasive " power.

The influence of tradition or habit—both psychological factors—on economic affairs is profound. The West African negro is said to be stimulated to buy by a red package, no other colour being so effective. The Chinese will more readily buy an article if it is marked with a known " chop." The British housewife would be amused at these crude instances without realizing that she herself is a bundle of prejudices and instinctive reactions. One may certainly secure from her habits the first specimen for a

museum of psycho-economic curiosities: prices which "look less"—19*s.* 11*d.* and 2*s.* 11¾*d.*—are still common at women's shops, although a "round sum" would obviously be simpler both for the purchaser and for the trader. A second specimen might be placed alongside the first: the prejudice which causes the officially defunct but aristocratic guinea still, after one hundred years, to oust the humble pound in many transactions—the doctor's fees, the fur coat, the annual subscription. These are unimportant instances of the obstinacy of tradition and habit, but they make it clear that the "pure reason" which would actuate an "economic man" really plays a relatively minor part in ordinary life, and that a true understanding of economic life will be more quickly achieved with the help of the science of psychology.

There can be no doubt that the general application of the science of Industrial Psychology will greatly increase the efficiency and reduce the wastes of industry while ensuring the consideration of human values. It is for the business man and the economist to study and use its principles and methods in order to secure the soundest and most permanent economic policy. The benefits which the Applied Sciences have in the past conferred are measured by the industrial revolution. The engineer, the chemist and the physicist have no doubt still greater

benefits to confer. It is the special province of Industrial Psychology to study the human effect of these changes. In this connection the words of a great economist are worth recording. Speaking of the work of the National Institute of Industrial Psychology, the late Lord Stamp said: "In its pioneer work in this field the Institute may be beginning a second industrial revolution of equal importance, in its raising of the standard of life, to the old industrial revolution which worked conversely in regard to the protection of human welfare. Is it too much to hope that Great Britain may be as much in the forefront of this work as it was in the mechanical revolution of one hundred and fifty years ago?"

CHAPTER XIII

INDUSTRIAL PSYCHOLOGY AND AGRICULTURE

By W. R. Dunlop

AGRICULTURE is the world's basic industry. It is also the world's largest industry, both as regards number of persons employed and capital invested. Even in Great Britain, which is predominantly a manufacturing and commercial country, agriculture employs as many people as any other one industry and involves a much greater investment of capital. The magnitude of agriculture is not easily realized because it is so spread-out geographically and because its individual units are economically so small.

An essential feature of agriculture is that it consists of two worlds of vital activity and conditions: first the world of human activity and conditions, and secondly the sub-world of plant and animal activity and conditions. Until quite recently scientific men have concentrated their attention on the latter and have almost entirely neglected the former. During the last fifty years the work in agricultural physics, chemistry, physiology, pathology and engineer-

instead of by the task); and secondly, from the neglect to give careful attention to movements and planning ahead and the proper arrangement and layout of materials. It is only possible to cite a few of the many cases investigated.

On a certain farm all the water is supplied by means of a hydraulic ram located near a stream about one mile from the farm buildings. In May 1927 a serious leak occurred in the pipe line. The writer took the opportunity of closely observing the methods adopted in the finding and mending of this leak. The men concerned (two ordinary farm workers and, later, a working hydraulic engineer) were followed and timed. Only a few salient defects can be recorded here. Leaving the farm buildings at 7 a.m., the two men took a route to the job which measured 800 yards, whereas a nearer and easier route measured 650 yards. They did not actually begin work (i.e. begin to dig one series of holes or trenches) until 7.45. At 8.29, however, they decided that they needed a special fork as well as spades, and one of the men had to go and fetch it from the farm buildings. Many other instances of faulty method and arrangement were observed, but let us pass to the second day, when the working hydraulic engineer arrived to test the exposed pipe-line. Water had to be removed from the holes while he was kept waiting. There was only one man to do this; so another had to

be fetched. Work was further delayed because the men refused to stand in the water. The engineer, having removed most of the water himself, discovered that he had forgotten the valve which has to be used with the pressure gauge and returned to his shop (two miles distant) to fetch it. The job was eventually finished at the end of a week. The above incidents are recorded because they took place on a very large farm which is considered to be exceedingly well run.*

On the same farm, by a similar method of observation, the man in charge of the cattle and pigs was found to take nine hours to do certain routine jobs which, by a re-direction of movements and inexpensive alterations, could easily have been done in eight hours. On the same farm, also, the shepherd took from 7 a.m. to 12 noon (5 hours) to visit and inspect 800 sheep. The conditions and circumstances were certainly exceptional in as much as they were of a temporary character. But they had been in existence for several months and could have been overcome to a great extent (*a*) by the use of a bicycle, (*b*) the employment of a suitable sheep-dog. (The dog used was trained for arable sheep-farming where the sheep are enclosed in

* It should be mentioned that the farmer of this farm spends a considerable proportion of his time attending markets. The actual supervision of labour is in the hands of an experienced and good type of foreman.

hurdles; he was unable to round up sheep properly in a large pasture.)

Finally the carter and his mate (in charge of the horses on this farm) were frequently observed to make unnecessary journeys and to cause unnecessary delays. Incidentally the carter lived three miles from the stables—a disadvantage when the working day (including overtime) begins at 5.30 a.m. and finishes at 5 p.m. Complaint was made of the absence of accommodation for meals, etc. The writer caused a disused harness-room to be fitted up as a mess-room, and this was greatly appreciated.

On other farms the operation of milking cows was studied. A certain amount of unnecessary waste of time was found to exist. This occurred mainly as the result of (*a*) "clean milk" processes, (*b*) delay in getting from one cow to another, (*c*) faulty cooling-room arrangements, (*d*) interruptions caused by retailing, etc. On certain farms the attempts to keep the milk clean by washing the cows' udders, and by the milkers washing their own hands, were very often a sheer waste of time and effort, although, of course, the intentions were excellent and were not to be discouraged. But very frequently the water used for washing was so dirty and contaminated with organic matter as to render the process valueless, if not actually injurious. The actual process of milking is sometimes greatly delayed by the presence of cows

which are extremely "hard" or difficult to milk.

The process of "lifting" or harvesting potatoes has also been studied. In this process a gang of women have to pick up the tubers as they are exposed by a mechanical digger drawn by a tractor. Unproductive time amounting, in respect of the machine, to as much as 55 per cent., and in respect of the pickers to as much as 60 per cent., was measured. Adequate rest pauses in this work are necessary; but allowing for these, there was usually unnecessary delay. It was mainly caused by one or two incapable or unwilling pickers holding up the whole team. Such work-people should be found other jobs of a more suitable character.

Finally, brief mention may be made of observations carried out on poultry farms, fruit farms and hop gardens. By revising methods and by making certain physical alterations, it is estimated that on a certain poultry farm the routine work of a man and woman which at present takes 80 hours per week could be done in 60 hours per week. The main principle here is to lessen the amount of walking, which at present occupies 60 per cent. of the time expended. The aim is to get as many operations as possible, such as the feeding, watering, etc., of the birds, carried out in the course of a single journey round the sheds. Improvements of a more technical character have also

been suggested concerning the birds and their physical environment. Even though our main concern is the human factor, it is impossible to disregard the plant and animal sub-world in the study of farming activity and conditions.

In the picking and packing of fruit there is considerable scope for the application of intelligence, and practical suggestions have been made to increase the ease and comfort of this work. In hop picking, which is closely allied to fruit picking, recent investigation has shown that one of the reasons why one picker is sometimes four times as " good " as another is because of less unproductive time expended in the collecting, or getting into position, the pieces of hop bine to be picked. In the course of 30 minutes' work, a " good " picker was observed to expend only 4 minutes in collecting her material; a poor picker on the same day and in the same garden expended 13½ minutes. This loss of time is not a matter merely of skill or of constitutional ability.

All the foregoing constitute faulty adjustments in the achievement of economic ends. But since the workers are a means and part of the environment of the farmer, it is among the farmer's own adjustments to see that his workers' adjustments are as correct as possible. Consequently (in so far as correction is possible) faulty manual operations reflect on the farmer's management.

The Study of Management

It should be a necessary function of the farmer and his foreman to see that the men and women carry out their operations in the most efficient manner under the most efficient conditions that are economically possible. But the essence of farm management, and therefore of farming, lies in the making of correct decisions both as regards general policy and giving effect to it. In plain language the essence of farming lies in devising a broad plan of action and then in taking the right action at the right time. The farmer's activity is, or should be, essentially mental. The old-fashioned conception of the ideal farmer —who can at a pinch perform the job of any one of his employees, who can judge the weight of a beast to the nearest pound, who knows how to grow (and often does grow) the finest crop of wheat in the district and who can strike the hardest bargain with the hardest dealer on the hardest markets—can no longer be entertained. Modern progress and conditions have rendered it obsolete. The farmer of the future, in addition to possessing a practical knowledge of processes, will have to be a man of higher training and intellect, capable of practising the principles of Scientific Management.

In the writer's opinion the study of farm management is essentially the study of the working of the farmer's mind in relation to his

physical, biological and social-economic environment—especially the last-mentioned. The extent to which he gives attention to the working conditions and methods of his employees is important. But much more depends upon the decisions which he reaches on the basis of scientific facts and by means of scientific and economic thinking in so far as this is possible. The fluctuations of weather and prices, and the incurring of working expenditure often a year before the receipt of revenue, admittedly render farming the most risky and perhaps the most difficult of all industrial occupations. Nevertheless there is scope for scientific thinking; and for this the farmer, whatever he may say to the contrary, has at least plenty of time.

The study of management in the directions described has not, so far as the writer is aware, in this country at least, yet been started. In this connection, one or two instances of wrong decisions, illustrative of possible improvements, which have been observed in the course of the writer's experience, are worth recording. A farm which grows a large acreage of early potatoes experienced, at the end of April 1927, 22 degrees of frost. The haulms or "tops" were killed and both the farmer and his foreman decided that the crop was ruined. They also decided that any further expenditure of money in the form of cultivation would be wasted. This second decision was, of course, a logical

corollary of the first. At the end of June the crop was examined and was found to be worth harvesting. As the work proceeded, the yield was found to be on the average exceedingly good, amounting to over 6 tons per acre. The crop was not ruined and the original decision was wrong. Incidentally, of course, the second decision was wrong. For, in the meantime, the fall of heavy rains had led to an enormous growth of weeds which caused the cost of harvesting to be increased by nearly twenty shillings a day—a much greater amount than it would have cost to prevent most of the weeds from growing at all. The delay also interfered with marketing at the most favourable moment. The essential point, however, is that the original decision was wrong. Could the mistake have been prevented by scientific thought and investigation? This is partly a question for the plant physiologist and agronomist. With all the recent advances in plant physiology and agronomy, it seems unlikely that a more accurate opinion on the matter would have been impossible. It is surely only a question of the vitality of the subterranean buds. The farmer, himself, with a little training might be expected to be able to investigate such a matter. On such a point as this the psychologist and plant physiologist meet on common ground.

Another case of incorrect decision will be referred to more briefly. It concerned a straw-

berry crop. The foreman in charge thought that the crop would be so small as to make it impossible to pay the pickers by piece-work. (It is a characteristic feature of agriculture that the lower the yield the more difficult it is to arrange for piece-work.) The crop, however, actually proved to be much heavier than was estimated; but the method of payment by the hour resulted in slow and slovenly work which reacted unfavourably both on the workers and on the management. The decision referred to here was unscientific because it was based on casual observation and not upon measurement. Crop samples should have been picked and weighed early in the operations. It was the present writer who, by going over the rows which had been presumably picked "clean," discovered by actually picking and weighing that what had been missed was equal in amount to what had been gathered by the workers in the first instance.

Wrong decisions of a much greater magnitude—decisions of policy—undoubtedly occur in farming, and there can be little doubt that the chance of their occurrence could be lessened by scientific thought and method. The truth of this view has not yet been fully and scientifically demonstrated. At the present stage it is little more than an assumption. But if true, it will open up wide issues in regard to agricultural education, concerning which the writer believes

that the most drastic reforms are necessary in this country. In such a new system of agricultural education, the guidance and selection of the future farming personnel—both farmers and workers—will be just as necessary as the provision of adequate and psychologically directed instruction.

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N.I.I.P. = National Institute of Industrial Psychology.

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